SYRIA
Agricultural Sector Assessment

Volume 2
Natural Resources Annex

U.S. Department of Agriculture
in cooperation with the
U.S. Agency for International Development
and the
State Planning Commission
Syrian Arab Republic

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PREFACE

As one of five volumes comprising the Final Report of the Agricultural Sector Assessment, this Annex contains the technical reports which relate to the natural resource base of Syria. The land resource reports were prepared as part of a contract between the U.S. Department of Agriculture (USDA) and the Comprehensive Resource Inventory and Evaluation System (CRIES) project. The CRIES project staff is constituted of personnel from the Soil Conservation Service, the Science and Education Administration, and the Economics, Statistics and Cooperatives Service of the USDA, and personnel from the Remote Sensing Project, Department of Resource Development, and Department of Agricultural Economics of Michigan State University. The reports on other resources were prepared by USDA consultants. Names of specialists are listed in the prefaces of the various Chapters.

Preliminary drafts of the technical reports were provided to the State Planning Commission (SPC) in September and October 1979. Revised drafts were reviewed by Committees established by the Prime Minister's Office in early 1980. The comments and corrections of these Committees are incorporated to the extent possible into this Final Report.

The Syrian Agricultural Sector Assessment Project was carried out by the Office of International Cooperation and Development, USDA, in cooperation with the U.S. Agency for International Development and the Syrian Arab Republic under PIO/T 276-005-2-80020. The participation of the Syrian Arab Republic was provided through the State Planning Commission of the Prime Minister's Office, under the general direction of Hisham Akhrass, Deputy Minister of State for Planning Affairs, SPC.

(Continued)

The Syrian Agricultural Sector Assessment Project was implemented under the supervision of the resident project staff which included: USDA - William A. Faught, Team Leader and Co-Director; Wendell M. McMillan, Policy Economist; and Calvin C. Boykin, Jr., Production Economist; and SPC - Said Halabi, Co-Director; and Nour Barmada, Assistant Co-Director, who was succeeded during the last six months by Raghad Sheik El-Ard. A complete listing of the many specialists and counterparts who participated in the project are listed in the Appendix to Volume 1.

The Final Report of the Agricultural Sector Assessment contains the following five volumes:

Volume 1 - Summary Report

Volume 2 - Natural Resources Annex

Volume 3 - Agricultural Production Annex

Volume 4 - Agricultural Marketing Annex

Volume 5 - Human Resources and Agricultural Institutions Annex

June 1980

Syria: Agricultural Sector Assessment

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CHAPTER I

LAND RESOURCES

Based on the work of
the CRIES Project

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PREFACE

This first chapter of the Natural Resources Annex presents major findings from studies made on the characteristics and potentials of Syria's land resources. The data are in terms of geographically identified resource units called Resource Planning Units (RPUs).

Major parts of this work, including the RPU descriptions, was carried out by Kenneth Ackerson in collaboration with LeForrest Miller of the Soil Conservation Service, USDA, and Alan Atchley and Eric Mathis of the Science and Education Administration, USDA. Clyde E. Stewart, USDA contract, provided information on RPU water resources. Richard Hill-Rowley of the Center for Remote Sensing, Michigan State University (MSU), managed the research activities summarized in this chapter. Scott Witter, also from this MSU unit, had primary responsibility for interpretation of the Landsat imagery. Also contributing to this work from MSU were: Stephen Tilmann, supervision of the geocoding and computer processing of mapped information, Eriks Zusmanis, development of computer mapping phases, and David Lusch and Valerie Stipe, cartographics.

All of these participants benefited from the continuing collaboration of Mohyed-din M. Taha, Chief, Mapping Department, and Abdul-Rahim A. Loulou, Agricultural Engineer, of the Directorate of Soils, Ministry of Agriculture and Agrarian Reform.

Others contributing to this work on land resources were: John W. Putman, James B. Johnson, Daniel E. Kugler and Calvin B. Boykin, Jr. of the USDA.

LAND RESOURCES

A. Introduction

Agricultural development in Syria depends in a fundamental way on the potential capabilities of the nation's land resources. In order to determine these potentials more fully, as well as to provide a basis for assessing alternative resource uses in the light of national development plans, a comprehensive inventory was made of agricultural land resources and current land use. This report presents the major findings on the characteristics and potentials of these resources in terms of geographically identified resource units called Resource Planning Units (RPUs).

In this introductory section, a general description of Syria's physical characteristics is given, along with a brief summary of the concepts and methodology used in carrying out this resource inventory. The next section shows the locations and areas of the RPUs, and contains detailed descriptions of each RPU in the country. The concluding section describes the present land cover and land uses in different regions of Syria as identified through visual interpretation of Landsat imagery.

General Description

Geographic Features

Syria lies in the Middle East between $32^{\circ}19'$ and $37^{\circ}20'$N and between 35° and $45^{\circ}25'$E. It has an area of some 185,000 km^2 and overlooks the Mediterranean in the west, the Taurus Mountains in the north, and embraces part of the Arabian steppe-desert in the southeast.

The Syrian coast is sandy and narrow and runs more or less side by side with a twin chain of mountains separated by a rift valley. Inland occur the branching of the eastern chain of mountains and some individual mountains.

Plains are located along mountain edges and near lowlands in the northwest bordering the Euphrates and its tributaries in the north-central region, and extending to the Jezireh in the northeast. The steppe-desert forms the southeastern part of the country.

Elevations range from 0-200 m along the Mediterranean shore, part of the Ghab Valley, along the Euphrates River and the foot of the Golan Heights, accounting for some five to six percent of the country, to more than 100 m in the mountains, composing about the same proportion of total land area. Separate mountains and high plateaus, including those in the southwest, cover about one-third of the country, the elevations ranging from 600-1000 m. Land with elevations between 400-600 m account for about 60 percent of the total land area and includes much of the central and southeastern sections of the country.

Climate

Syria has a climate generally considered as modified Mediterranean, which is characterized by four distinct seasons. Winter is notably a cool and rainy season, although snow sometimes occurs. The country is sometimes affected by high pressures and migratory anticyclones which are associated with clear sky, bright sunshine and sharp decreases in temperatures. Summer is normally hot and dry with clear sky, no precipitation, and high temperatures. Spring and autumn are relatively shorter in duration.

The two factors affecting precipitation are the general weather situation and topography, the amount of precipitation received increasing with the frequency of the passages of depressions and with elevation. Except for the windward side of mountainous areas, precipitation generally decreases from the west and north to the east and southeast. Breaks in the mountain chains allow for the penetration of relatively higher quantities of precipitation inland.

The rainy season begins in September over the coastal and northeastern areas and spreads all over the country in October, reaching its maximum in December and January. It ends in May, except for the coastal area, where it extends to June. Precipitation rarely occurs during July and August.

Average total yearly precipitation is 100-150 mm in the southeastern part of the country, 150-200 mm in a band from the south toward the center and east-central areas. In the plains and at the edges of mountains along the western side of the country, average total yearly precipitation ranges from 300 to 600 mm increasing in the mountains to 1400 mm. Along the coast average total yearly precipitation is 800-1000 mm.

Air temperatures are affected by such factors as solar radiation, air masses, topography, and type of earth surface. Temperatures decrease with increasing elevation. With the exception of mountainous areas, the coastal area is milder in winter and cooler in summer than the rest of the country. The eastern and southeastern parts of Syria are warmest in winter while the eastern and northeastern parts are hottest in summer. January is the coldest month of the year; August is the hottest summer month.

Average minimum temperatures in January range from 0-2°C in the foothills and adjoining plains to -2°C in the higher mountains, and 6-8°C along the coast. Average maximum temperatures in January range from 14°C in the northeast and 16°C along the coast, to 6-8°C in the mountains.

Average maximum temperatures in August are 38-40°C in the northeast, east and southeast, and 26-30°C in the higher mountains and along the coast. The average minimum temperature range is 12-22°C in the higher mountains and 24-26°C elsewhere.

Soils

Land in Syria generally has been divided into seven soil categories:

Red Mediterranean Soil. These soils are found where annual precipitation averages around 600 mm. The dominant color is red, these soils being clay loam and loam morillonitic with little horizonation, some clay movement. pH measures 7-8. Some Mediterranean and some grumusols are found in the western hills of Syria. (Every patch of arable and marginal land is utilized after clearing of stones or terracing.)

Grumusols. Dominant colors of these soils are dark red, brown, dark brown and black, found where the average precipitation is 300-600 mm. Being montmorillaite, the pH is about 8.5. There is no horizonation. These soils occur in the plains and western and northwestern Syria - the wheat belt. Under irrigation they are suitable for growing cotton.

Cinnamonic. These soils are found where the annual average precipitation is 150-300 mm. The dominant color is reddish-yellowish brown, being montmorillonite-attapulgite loam and clay loam, highly calcareous. pH is 8-8.5. Calcium concretions and sometimes calcium horizons are common and the structure is unitable. These soils are found in the interior plains of Syria on which barley is planted.

Desert. These soils occur where the average annual precipitation is less than 150 mm. The dominant colors are brown-gray and gray and the soils consist of highly calcareous loam. This land is used for livestock grazing.

Gypsiferous. The dominant color of these soils is yellowish-orange brown. They are powdery and easily subject to wind erosion. With a pH of 7, they are often gypsiferous and subject to crusting. Permanent agriculture is possible only under irrigation; otherwise these soils are used as natural grazing land of low capacity.

Alluvial. These are gray, sand loam-to-clay soils with a pH of 8. They are found mainly in the low valleys of the Euphrates River and its tributaries. The present use is for irrigated cotton, but these soils are suitable for other crops.

Groundwater Soils. These soils include bog organic, diatomeceous earth, gray and brown calcareous and saline groundwater soils. They are located in the plains of the Ghab, Rouge, Radd and the inland lakes of Syria.

Water Resources

There are some 16 rivers in Syria, the largest being the Euphrates with a length in Syria of 602 km and an average flow rate of 1042 m^3/sec. Al-Khabour and its tributaries have a length of 405 km and an average flow rate of 43 m^3/sec., while the Orontes and tributaries run some 325 km in length and have a flow rate of 51 m^3/sec. The other rivers are shorter and have lower flow rates.

There is one grand dam at Al-Tabka on the Euphrates with a storage capacity of 11,600 million m^3. Some 640,000 hectares of land is scheduled for irrigation from Lake Al-Assad created by this dam. Medium-sized dams include the Al-Rastan, 225 million m^3 storage capacity; the Mouhardeh, 50 million m^3; and the Taldo, with a storage capacity of 15.5 million m^3. There are also some 20 dams classed as small, the largest of which is the Dar'a dam with 15 million m^3 storage capacity. Most of these small surface dams are located near Homs and Hama, although there are two each near Lattakia, Aleppo and Al Hasakeh, the others being spotted from Damascus to Deir-ez-Zor.

Other than Lake Al-Assad, there are five lakes in Syria. The largest is Lake Jabboul near Aleppo with 265 km^2 of surface area. The others, near Homs, Damascus and Al-Hasakeh are much smaller. Lake Qattineh, however, with a surface area of 60 km^2 is the principal lake in Syria that remains full all year long.

Springs with a flow rate exceeding 400 l/sec are numerous, most of them near Damascus, Dar'a, Homs, Hama, and Lattakia. Underground water supplies are developed or being developed where available through pumping for several uses, including irrigation and livestock needs. Although not all wells have been licensed for pumping, there are almost 4,000 licensed wells in Syria, the majority in Homs, Idleb, Al-Rakka and Al-Sweida Mohafazat.

The area which lies to the north of an imaginary line extending between Damascus and Al-bu Kamal is a region of small wells which provide water for domestic and livestock needs. Most of the wells are less than 15-20 m in depth, although there are some as deep as 60-70 m. All the functioning wells do not yield potable water. The wells to the north in general yield much more water than those to the south of the Damascus to Al-bu Kamal line. However, the total output in both areas combined is very small.

Stabilization and Other Zones

Syria has been divided into five zones or agricultural areas, the criteria being principally the average annual precipitation received and the probability of receiving a certain amount of precipitation in a series of years. Three stabilization zones are useful in examining cropland agriculture from the standpoint of crops grown, yields, and uncertainties of production as related to precipitation. These zones are also indicators of potential forage and crop residues available for livestock grazing. At the same time, the zones have been identified in order to assist with land-use planning, particularly to indicate where a stable system of cropping can be expected and to serve as a guide to which lands should remain in crops or be re-established to range or forests.

Of the 18.5 million hectares of land in Syria, steppe and pasture claim the largest share, some 47 percent, while about 32 percent is cultivable land. While 92 percent of the cultivable land was cultivated in 1975, only about 14 percent of the land in cultivation was irrigated. Uncultivable lands, not including forests, steppe and pasture, amount to almost 19 percent of the total land area.

Stabilization Zone One. This zone, with an average annual precipitation of 350 mm, or more, has been divided into two subzones:

(a) An area with an annual precipitation rate over 600 mm where nonirrigated crops could be successfully planted, and

(b) An area with annual precipitation between 350-600 mm and more than 350 mm during two-thirds of the related period; that is, it is possible to get two field-crop seasons each three years. The main crops are wheat, pulses and summer crops.

Two-thirds of the entire zone is classed as cultivable land, with almost 84 percent of this land being cultivated in 1975. Over 10 percent of the cultivated land in crops was irrigated the same year. About 10 percent of the total area consists of forests and 7 percent is pasture.

Stabilization Zone Two. Receiving an average annual precipitation of 250-350 mm and more than 250 mm during two-thirds of the related years, this zone can get two barley seasons each three years. Besides barley it is possible to grow wheat, pulses and summer crops. Over 81 percent of this area has been classed as cultivable land, practically all of it was cultivated in 1975. Slightly more than 8 percent of the cultivated land in crops was irrigated. Almost 6 percent of the land was in pasture. Over 38 percent of the cultivable land was fallowed.

Stabilization Zone Three. This zone has an average annual precipitation rate of over 250 mm and not less than this during half of the relative years. It is possible to get one or two yield seasons each three years. The main crop is barley. Pulses could be planted.

Almost 70 percent of the land has been classed as cultivable and almost 16 percent as pasture. About 43 percent of the cultivable land was fallowed, while over 10 percent of the land in crops was irrigated.

Other Zone Four. This zone has been referred to as a stabilization zone, although it is marginal area for crops. Annual rainfall averages 250 mm and not less than 200 mm during half of the related years. Barley is planted in this area, although the zone is considered to be good grazing land.

Over 54 percent of the zone has been classed as cultivable land and 34 percent as steppe. Although 89 percent of the cultivable lands were cultivated in 1975, almost 52 percent of the cultivated land was fallow. Over 5 percent of the land in crops was irrigated.

Other Zone Five. This zone encompasses what is referred to as the Steppe. It covers the remainder of the land area of Syria and is not suitable for non-irrigated agriculture. Average annual precipitation amounts to less than 150 mm. Almost three-fourths of the zone is classed as steppe and only 2 percent as cultivable. While over 96 percent of the cultivable land was cultivated in 1975, all of the land in crops was irrigated.

Concepts and Methodology

The land resources of Syria were cartographically delineated into Resource Planning Units (RPUs). The characteristics of the RPUs were further described by unmapped Production Potential Aareas (PPAs) with the extent of each PPA approximated.

These RPU and PPA concepts are briefly summarized in the following paragraphs, along with the main features of the underlying land resource classification system. Details are given in Appendix 1.

The RPU and PPA Concepts

The concepts and definitions of RPUs and PPAs reflect the relationships among soils, climate, and plant growth. The natural landscape may be viewed as an intricate complex of similar and dissimilar climate, soils, and vegetations which occur in a consistent, regular, and/or repeating pattern. The delineation of the landscape into these natural, physiographic, and ecological map units (RPUs) satisfies the Land Information Subsystem's need for geographically identifiable units. RPUs are generally composed of a variety of similar and often contrasting soil bodies and topoclimates which may occur in complex spatial patterns. Such complexities are generally regular and repeating and are uniquely different from the spatial patterns and complexities of other RPUs.

The interpretation of RPUs for plant adaptability, productivity, and management requirements must take into account the consideration of soils and topoclimates in greater detail. The Production Potential Areas (PPAs) become the analytical units within each RPU. The PPAs generally reflect major soil bodies and associated topoclimates.

RPUs and PPAs are specifically defined as follows:

Resource Planning Unit. An RPU is a geographically delineated unit(s) of land (not necessarily contiguous) that is relatively uniform with respect to land forms, kinds and patterns of soil bodies, climates, and potential vegetation.

Production Potential Area. A PPA is an aggregate area of individual soil bodies and associated topoclimates within an RPU which is sufficiently homogeneous with respect to plant adaptability, potential management requirements, and productivity to be reliably depicted by unique estimates of those parameters for national analysis and planning.

RPUs serve several purposes. They divide the landscape into natural, physiographic planning and implementation units. RPUs serve as reference points for field technicians. They are described with respect to their climates, physical characteristics, and major soil components (PPAs) to provide a device to screen development options. They give the geographic reference for the Land Information Subsystem to merge, cross-classify, and aggregate mapped natural resource data from various sources with tabular data by administrative boundaries.

PPAs are taxonomically definable and could be mapped. However, policy choices and priorities can be based upon estimates of the area, distribution, and patterns of PPAs within an RPU. Detailed investigation and mapping can be more efficiently programmed after national policies and priorities are established.

PPA estimates provide the interpretation of crops adaptability, productivity, and management requirements based upon assumptions of relatively homogeneous soil and crop climate properties for the analyses of planning and management options. However, the distribution, size, and associations of the individual PPAs and their patterns with respect to other PPAs must also be known to aid planners in screening management options for program implementation.

Patterns of PPA distributions and the management constraints they impose are defined as follows:

Intricately Patterned PPAs. When two or more PPAs generally occur in patterns composed mostly of individual PPA bodies of less than five hectares, they will be described as intricately patterned. For national planning, such PPAs are considered as a single unit and represented by a single-valued input coefficient (productive factors) and an output (yield) coefficient.

Finely Patterned. When two or more PPAs generally occur in patterns composed of individual PPA bodies usually larger than five hectares they will be described as finely patterned. For national planning, finely patterned PPAs are considered as individual units for most management options but carry size constraints for some program and project purposes.

Coarsely Patterned. When individual PPA bodies occur within an RPU in coarse patterns that are predominantly larger than 100 hectares, they are described as coarsely patterned. Such PPAs are treated as separate units for national planning.

Consider the following example: An RPU consists of a mountain range intersected by small valleys. Two PPAs, representing the flood plains and terraces, within the RPU are described as coarsely patterned in the valleys. Two intricately patterned PPAs, one with deep, fertile soils and the other with shallow, rocky, infertile soils, form the mountain portion of the RPU. Because the valley PPAs are coarsely

patterned, different programs for the management and utilization of the two PPAs can be considered and both can be planned independent of the mountain PPAs. The two mountain PPAs, however, must be planned as a single unit because they are intricately patterned. Hence, expected crop output for planning purposes would be a single-valued estimate reflecting uniform management (and like applications) of the two mountain PPAs.

Methods and Materials for Classification

Soils. In order to work with the concepts of the RPUs and PPAs, a knowledge of the kind and distribution of soils is essential. This knowledge can most easily be acquired from published maps and reports dealing directly with the subject or from data dealing with subjects related to soils and soil genesis, e.g., geology, vegetation, climate, etc.

In Syria, information about the kinds and distribution of soils is found mainly in generalized studies dealing with the country as a whole. Some additional detailed information is in special studies prepared for irrigation and drainage projects. In general, however, data on the environment, the physical and chemical properties of the soils, and cultural practices were relatively meager. Syrian soil scientist counterparts supplemented the documentary material with data from their personal knowledge and experience. Some of these data were gathered on special forms and applied to the map units on van Liere's Soil Map of Syria. The form used for collection of these data is included in Appendix. 1.

By using all available descriptive materials, the soils were reclassified in terms of Soil Taxonomy, a soil classification system developed by the USDA. For those areas that had not been classified earlier, classification was inferred from available data on geology, climate, vegetation, topography, and geologic age.

Crop Climate. The source of climatological data used in this study was the Climatic Atlas of Syria and its accompanying Agriclimatological Reference Book for the Syrian Arab Republic. Climate data files of the Agricultural Ecological Geographic Information Systems (AEGIS) of the Economic Botany Laboratory, USDA, were also consulted. Floristics data were obtained from a vegetation map of Syria and an accompanying plant list provided by the Director General of Soils, MAAR. Details of the crop climate map units are given in Appendix 1.

RPU/PPA Delineations. As previously discussed, RPUs are broad segments of landscape in which climate, soils, and vegetation occur in consistent, regular and/or repeating pattern. The actual process of delineating RPUs for Syria involved superimposing transparent copies of the soil and crop/climate maps over the topographic maps that were used as reference maps. Areas uniform in respect to both climate and soil are outlined. In some situations, PPAs could be identified on the basis of physical characteristics but the potential for agricultural use might not be significantly different; or a single overriding factor may dictate the potential, or lack of it, for economic use. In these examples, an RPU would be identified but not be divided into PPAs. As an illustration, the most simple RPU is one in which a single kind of soil on uniformly sloping topography occurs in a single climatic region, e.g., a hypothetical area of heavy clay soils on undulating (slopes 3-8 percent) basalt plains in a temperate climatic region having 350 mm annual precipitation which falls mostly during the December-February period. The average monthly precipitation during the wet season is well over 60 mm; the average temperature during that period is 9°C, and the location is frost free.

In contrast, RPUs comprising more than one kind of soil and/or topographic situation in combination with climatic regimes which differ over short distances or with changes in altitude, aspect, and/or latitude represent situations which commonly occur. To subdivide a complex area into a series of less complex environments could provide detail considered more appropriate for project planning than for national planning.

The criteria for establishing PPAs are perhaps best described by example. Consider a geographic area consisting of steeply sloping limestone ridges with shallow, stony soils separated by level or nearly level ground with deep nonstony soils; the two kinds of landscape are of nearly equal extent. For purposes of this illustration, climate is uniform throughout the area. Neither landscape is sufficiently extensive to be considered an RPU, so the two landscapes are considered together for planning purposes. The steep ridges comprise one PPA and the intervening level ground comprises the other PPA; each has unique potential, or lack of it, for agricultural use.

The proportion of an RPU that is represented by a PPA is estimated on the basis of the resource scientists' accumulated knowledge about the RPU. In some instances the figure can be based on field observations, in other cases by use of reference maps, and in yet other situations by use of judgement and previous experience. Rarely would precise measurement of the extent of PPAs be feasible.

Further appreciation of the influence of the major determinants on the delineation of the RPUs can be gained from reading of the individual RPU descriptions. As previously discussed, PPA delineations were influenced by several major determinants including annual climatic characteristics, wet season climatic characteristics, soil characteristics and topographic characteristics. Using the detailed RPU and PPA descriptions and a cross-referencing by computer of the RPU map, soil map, and crop climate map, a summary of the influences of the major determinants on PPA delineations within RPUs was developed (Table 1). (Please be aware that the topographic map was not computer-referenced against the RPU map and that a vegetative cover map was not available to computer reference against the RPU map).

Preliminary Nature of RPU and PPA Delineations.

The RPU and PPA delineations were developed through judgemental processes in the collaborative efforts of the U.S. and Syrian team participants. These collaborative efforts are viewed as building on past research efforts on similar topics during the brief period of the natural resource inventory and assessment. Although the RPU and PPA delineations should be considered preliminary, they provide a basic framework for continued review, refinement, and revision as new and improved information on underlying determinants become available. The process of delineating the preliminary RPUs and PPAs should be viewed as just one additional step in the continued elaboration of information needed to develop and accomplish the agricultural development goals of Syria.

Considerable interest has been expressed by Syrian scientists about moving from judgemental processes to deterministic methods and procedures in the delineation of RPUs.

A proposed procedure for deterministically deriving the RPUs has been outlined through the collaborative efforts of U.S. and Syrian scientists. If such an attempt were undertaken, it would involve three interrelated activities. The first activity

would require geocoding existing and/or additional maps developed on climatic features of Syria. Composite maps considering several climatic features would be produced. The second activity would involve relating the computerized ecological amplitude information of the Economic Botany Laboratory of the Science and Education Administration, U.S. Department of Agriculture, with the composite climatic features maps developed in the first activity. The third activity would be the development of a plant life zone map for Syria through the use of plant species. This procedure would require at least two to three person-years of extensive field work for completion. The completed plant life zone map would provide a basis for comparing vegetative cover with the composite climatic features maps to determine the best fits (least variation) between plant life zones and composite climatic maps.

Geocoding of RPUs and Associated Information. The soil, crop/climate and RPU maps developed as described above were geocoded and incorporated into the computerized Land Information Subsystem which is described in detail in Appendix 2. Also incorporated in this system was mapped information on administrative boundaries, stabilization zones, hydrologic units and land cover/use areas. Any of these categories of mapped information can be cross classified with any other and the area (e.g., km^2 or hectares) in each cross classified category can be determined. By this process statistical information reported by administrative units such as major land uses could be related to RPUs.

Table 1 -- Influence of Major Determinants for Delineation of PPAs Within RPUs.

RPU	Number of PPAs	Annual Climatic Characteristics	Wet Season Climatic Characteristics	Soil Characteristics	RPU	Number of PPAs	Annual Climatic Characteristics	Wet Season Climatic Characteristics	Soil Characteristics
1	2			X	30	1			
2	2	X			31	4	X	X	X
3	2			X	32	2			X
4	1				33	2			X
5	6	X		X	34	2	X		
6	2	X			35	3	X		X
7	3			X	36	1			
8	2			X	37	2	(topography)		
9	4		X	X	38	3	X	X	
10	1				39	2			X
13	2			X	40	4	X	X	X
15	1				41	3		X	X
16	2	X			42	2			X
17	1				45	1			
18	3			X	46	3		X	X
19	2			X	47	1			
20	3	X		X	48	1			
21	2			X	49	1			
22	1				50	3	X	X	X
23	2	X	X		51	3	X		X
24	6	X	X	X	52	3	X	X	
25	2			X	53	2	X		
26	2		X		54	2		X	
27	4	X	X	X	55	1			
28	1				56	2		X	
29	1				57	1			
					58	1			

Note: When an RPU consists of a single PPA, two situations may have occurred. In the first situation, each of the major determinants of PPA delineations exhibit an homogeneous influence. In the second situation, one of the major determinants of PPA delineation may constrain the RPU to a single PPA. For example, a particular RPU may have a broad range of climatic features, but the soils are so shallow and steep that agricultural potential is limited; therefore, due to the soil conditions being such a limiting factor to agricultural potential, no PPAs would be specified on the basis of climate.

B. Detailed RPU Descriptions

The location of RPUs is depicted in Figure 1, and their extent, expressed in hectares is reported in Table 1.

RPUs 11, 12, 14, 27, 43, and 44 have been combined with other RPUs due to the high degree of similarity with respect to plant adaptability and productivity. The final map shown in Figure 1 is a result of completion of field work in Syria and analyses of soils information, climatological data, and other related information pertinent to the delineation of RPUs.

Detailed descriptions of each of the RPUs and PPAs are presented in this section. The type of information included in the descriptions can be outlined as follows:

The general description characterizes the physical environment of the RPU -- landform, slope, elevation, climate, extent, and general location within the country. A statement about the PPAs comprising the RPU is included, and identifies the basis on which the PPAs were separated and the pattern of their occurrence.

Production potential areas are described in greater detail. In addition to the general configuration of the landscape, dominant soils in the PPA are characterized by properties most significant to agricultural use, e.g., depth, texture, drainage. Climate is described in terms of temperature, rainfall, and length and intensity of the wet season. The salient features of soils and climate are interpreted in terms of recommended use for the PPA.

The current vegetative cover of the RPU is recorded under reported or observed crops and vegetation. The crops listed either have been reported to be grown in the area of the RPU or have been seen by observers during field work conducted prior to the preparation of this report. Similarly, natural vegetation is also discussed and species enumerated.

Water resources and uses are brief descriptions of sources of water (rivers, springs, wells, reservoirs) and current water use in the RPU. Capacity of reservoirs is expressed as m^3 (cubic meters), either billions, millions or thousands. Flow of springs is expressed as l/sec. (liters per second). Also the magnitudes given are totals for all springs referenced; that is the amounts are not averages per spring unless specifically stated. The flow are, however, annual averages. Capacities of wells are expressed in m^3/hr. On a continuous pumping basis, this rate amounts to 8,760 m^3 per year which is about the plant requirements for a growing season of six months or less. At eight hours per day for six months total yield would be 1,460 m^3. Discussions in Syria about water requirements frequently were referenced with a magnitude of 0.50 l/sec./ha. A flow of 0.50 l/sec./ha.would amount to 15,676 m^3/year or, for example, 7,839 m^3/ha./6 months growing season. The latter quantity may be adequate in most areas of Syria for a diversified cropping pattern. Some crops, e.g. cotton, and areas e.g., Euphrates Basin, would require more water than this amount.

Crop recommendations are statements of the adaptability of groups of cultivated crops to the soil and climate of the PPA as well as the feasibility of producing them.

A summary table of PPA properties concludes the description of the RPU. This table contains the specific data on which the more generalized statements in the descriptive text are based. Definitions or descriptions of the RPU and PPA features discussed in these summary tables are the following:

Figure 1. -- Resource Planning Unit Map for the Syrian Arab Republic, June, 1979.

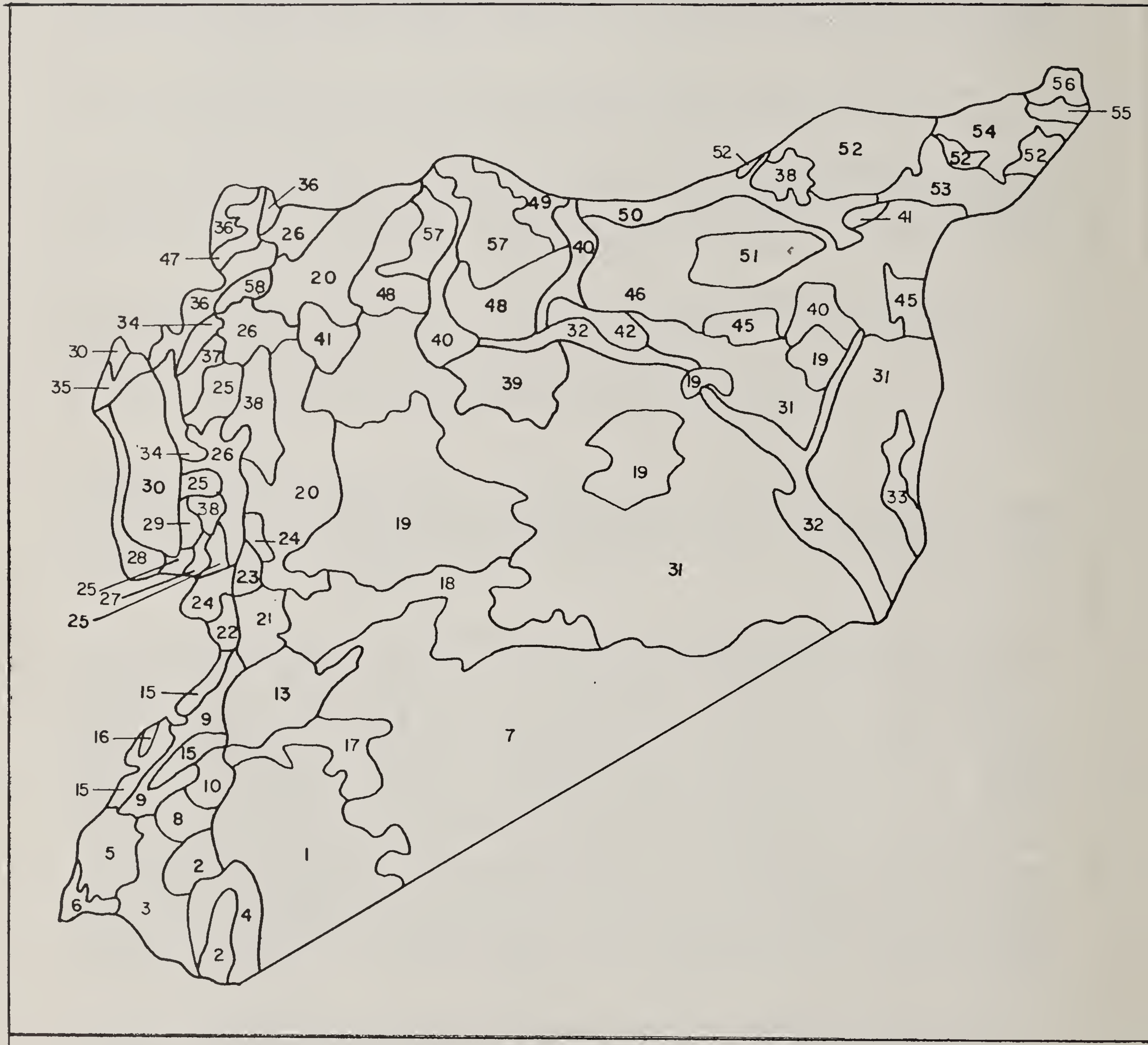


Table 2.-- Extent of Resource Planning Units (RPUs) estimated from geocoded mapped information.

RPU	Extent of RPU (hectares)	RPU	Extent of RPU (hectares)
1	965,100	30	337,100
2	183,200	31	4,155,600
3	328,000	32	343,000
4	156,500	33	60,400
5	183,400	34	86,000
6	57,000	35	42,500
7	2,407,800	36	207,500
8	94,000	37	54,400
9	163,500	38	258,400
10	68,400	39	246,800
13	289,400	40	291,100
15	150,100	41	114,400
16	7,100	42	91,200
17	194,400	45	139,500
18	568,400	46	1,021,000
19	1,317,200	47	48,700
20	833,000	48	398,200
21	120,400	49	87,100
22	44,300	50	193,500
23	38,400	51	223,800
24	90,900	52	462,500
25	202,000	53	140,700
26	383,500	54	156,100
27	25,400	55	31,100
28	92,600	56	40,400
29	24,800	57	415,600
		58	44,900
Country Total			18,719,300

General

elevation - commonly, the range in elevation of the RPU above sea level; read in meters from topographic maps.

Dominant range of slope - range of slopes in the RPU; reported by Syrian scientists and read from topographic maps.

portion of RPU - the proportion of the RPU represented by the PPA; estimated from background knowledge of landscapes, soils, and climate.

Climate

annual characteristics - the nature of the climate expressed as averages for the year.

average annual precipitation - the average precipitation as interpolated from the appropriate map in the Climatic Atlas of Syria, is denoted by the sign (#); when available, the arithmetic average of annual precipitation for the years of record for all weather stations in the PPA is reported in parentheses ().

average annual temperature - the average temperature as interpolated from the appropriate map in the Climatic Atlas of Syria, is denoted by the sign (#); when available, the arithmetic average of annual temperature for the years of record for all weather stations in the PPA is reported in parentheses ().

wet season characteristics - the nature of the climate expressed as averages for those months of the year that have rainfall significantly greater than one-twelfth of the average annual precipitation.

average monthly precipitation - an estimate of average monthly precipitation was made through the consideration of precipitation characteristics in similar areas and denoted by the sign (@); the arithmetic average of the monthly precipitation was calculated from weather station data applicable to the PPA (when station data were available) and reported in parentheses ().

average monthly temperature - average monthly temperature was interpolated from the appropriate maps in the Climatic Atlas of Syria denoted by a plus (+) sign; the arithmetic average of the monthly temperatures was calculated from weather station data applicable to the PPA (when station data were available) and reported in parentheses ().

period of wet season - months of the year included in the wet season.

Soils

principal components - the dominant soil or soils (commonly no more than two) that characterize the PPA; classified according to Soil Taxonomy.

depth to bedrock - depth measured from surface to bedrock; from data provided by Syrian soil scientists and from published reports.

texture - groups of classes of soil based on the proportion of sand, silt, and clay; coarse - dominated by sand; fine - dominated by clay, and medium - either domi

nated by silt or a mixture of sand, silt, and clay without an apparent predominance of one particle size.

coarse fragment - rock fragments larger than sand; generally gravel, cobbles, and stones; from data provided by Syrian soil scientists and from available descriptive information.

permeability - the ease with which air and water pass through the soil; estimated from available data.

reaction - the relative acidity or alkalinity of the soil; estimated from available information and data provided by Syrian soil scientists.

salinity - the presence of toxic salts that would interfere with plant growth; estimated from available information and data provided by Syrian soil scientists.

available water capacity - the capacity of the soil to hold water that can be absorbed by plants; interpreted from available information.

drainage class - a category of natural drainage conditions inferred from surface runoff, permeability, and internal drainage; inferred from available information.

Interpretations for Agriculture

inherent productive capacity - the capacity of the soil to produce acceptable yields of adapted crops; inferred from available information on soil mineralogy, parent materials, soil reaction, and moisture relationships.

susceptibility to erosion - inferred from available data on kind of soil, range of slope, and soil texture, and without consideration of current land use or vegetative cover.

most intensive land use - recommended use affording maximum sustained production of cultivated crops or permanent vegetation consistent with the potentials and limitations imposed by the soils and climate.

RPU 1

GENERAL DESCRIPTION:

RPU 1 is an area of predominantly undulating plains comprising soils that are shallow over basalt. It is estimated to cover approximately 965,100 hectares, and consists of one area southeast of Damascus. Elevation ranges from about 700 to 1000 m above sea level. The mean annual temperature is 17^{o} to 20^{o}C. Annual precipitation ranges from 100 mm to 200 mm.

The RPU consists of two coarsely patterned PPAs distinguished mainly on the basis of soil depth and related differences in moisture holding capacity. The climate is similar for both PPAs.

PRODUCTION POTENTIAL AREAS:

PPA 1-1 consists of the rocky basalt plain, approximately 90 percent of the RPU. The soils are Lithic Torriorthents, shallow, medium-textured and stony. Slopes are generally less than 8 percent. Because of shallowness to bedrock and stoniness, the soils in this PPA have little potential for farming. Locally, deeper and less stony areas could be cultivated by hand. Some grazing is afforded by native vegetation.

PPA 1-2 includes two small areas in the western part of the RPU. The soils are Typic Torriorthents and Typic Calciorthids. Both are deeper than the soils on the basalt plains in PPA 1-1, and both have aridic moisture regimes. Because of greater depth, medium-textured profiles, and greater moisture holding capacity, they have a potential for well managed irrigation farming if sources of water could be developed.

During the wet season (Oct. through April) in both PPAs, the average monthly precipitation is less than 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops have not been reported for this RPU. However, serious overgrazing was noted.

The vegetation is, in part, listed below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica

Tamarix spp.
Frankenia spp.
Halocnemum strobilaceum
Salicornia herbacea
Salsola crassa
Statice palmyrensis
Aelurepus littoralis
Sphenopus divaricatus
Juncus maritimus
Halogeton alopecuroides
Stipa parviflora
Onobrychis ptolemaica
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.

Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri

WATER RESOURCES AND USES:

Except during rainfall, surface water sources are entirely lacking. No springs are reported. The government has under construction a reservoir, capacity 2.2 million m^3, for use in Zulaf which seems to be the only sizable village in the RPU. A small reservoir, capacity 270,000 m^3, is under construction for domestic use. Nine Ministry of Public Works test wells have an average depth of 185 m with static level 72 m and dynamic level 99 m. Yield of these wells averages 9.3 m^3 hr. The seven Water Basin Administration wells were shallower -- 70 m; test information was not available. Most of the test wells are in basalt formation or combination basalt-limestone.

This arid, livestock - pasture RPU is in the Syrian Desert and Damascus hydrologic basins. Major uses of water are for domestic and livestock needs. Water comes from meagre rainfall and a large number of wells. Except for possible small isolated areas, there is no indication of irrigated crop production now or in the future.

CROP RECOMMENDATIONS:

RPU 1 is divided into two PPAs on the basis of soil characteristics. The climate depresses all potential for rainfed agriculture, so the soil-based PPAs must be evaluated with irrigation in mind. PPA 1-1 would scarcely be improved by irrigation. PPA 1-2 is unsuited for rainfed production of conventional major crops. With irrigation, however, it may be rated high for some nonrosaceous fruit trees, as well as some vegetables, and medium for small grains, cotton, tuber/root crops, olives, and pulses.

PPA PROPERTIES	1-1	1-2
GENERAL		
elevation	700-1000 m	700 m
dominant range of slope	3-8%	0-3%
portion of RPU	90%	10%
CLIMATE		
- Annual Characteristics		
average precipitation	100-200 mm# (103 mm)	100-200 mm# (202 mm)
average temperature	17-20°C# (19.3°C)	17-20°C#
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@ (13 mm)	< 38 mm@
average monthly temperature	10-12°C^{+}	10-13°C^{+}
period of wet season	October through April	October through April
SOILS		
principal components	Lithic Torriorthents	Typic Torriorthents Typic Calciorthids
depth to bedrock	less than 50 cm	more than 1 m
texture	medium	medium
coarse fragments	stony	nonstony
permeability	moderate	moderate
reaction	alkaline	alkaline
salinity	nonsaline	nonsaline
available water capacity	low	moderate
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	low	moderate to low
susceptibility to erosion	low	low
most intensive land use	rangeland	cropland-irrigated

RPU 2

GENERAL DESCRIPTION:

RPU 2 consists of rolling basalt plains with predominantly shallow, stony soils. The mean annual temperature range for this RPU is 10^o to 17^oC. Annual precipitation ranges from 150 mm to 500 mm. The RPU is estimated to include an area of approximately 183,200 hectares distributed in two areas in the southwest part of the country. Elevation ranges from 600 to 1600 m.

The RPU is divided into two coarsely patterned PPAs on the basis of climate.

PRODUCTION POTENTIAL AREAS:

PPA 2-1 comprises the southern part of the southernmost area of RPU 2. During the wet season (Nov. through Mar.) the average monthly precipitation is 38 to 45 mm.

PPA 2-2 comprises the northern area and the northern part of the southern area. It has slightly higher rainfall than that of PPA 2-1. During the wet season (Nov. through Mar.) the average monthly precipitation is 57 mm.

The soils for both PPA 2-1 and PPA 2-2 are Lithic Xerorthents and Lithic Torriorthents, shallow stony soils which are intricately intermingled with rock outcrops. Although the soils are well supplied with plant nutrients and have moderate to high base status, moisture holding capacity and rooting depth are limited by shallowness of soil over bedrock. Distinctions between the soil climate regimes are not sufficient to greatly affect use of the soils. They are suited for use as pasture and rangeland, except that in local areas of deeper soils some cultivated and tree crops can be grown under irrigation.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops for RPU 2 include fruit trees, such as cherries, peaches, and plums, grain, figs, olives, grapes, eucalyptus, and poplars.

Natural vegetation includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Lactuca orientalis
Centaurea damascena
Astragalus spp.
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althea rufescens
Onosma alleppica
Phlomis damascena
Bromus danthoniae
Cousinia aleppica
Salvia spp.
Trigonella sp.

Astragalus tribuloides
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Quercus calliprinos
Crataegus azarolus
Pistacia atlantica
Pyrus syriaca
Acer hermonis
Leguminosae
Dactylis spp.
Salvia spinosa
Evax contracta
Stipa spp.
Hypecoum pendulum
Stipa spp.
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus
Astragalus hermonous
Lonicera nummularifolia
Polygonum libani
Bromus tomentellus
Ranunculus chionophilus
Festuca valesiaca
Secale montana
Isoetes olympica
Malva aegyptiaca
Filago spathula
Trigonella radiata
Helianthemum aegyptiacum

WATER RESOURCES AND USES:

The RPU is in the Upper Yarmouk Basin and comprises two sections, north and south of Al-Sweida, but not including Al-Sweida. The southern section includes Salkhad and other smaller villages while in the north section there are few, if any, villages. No reservoirs or streams are apparent in the north. Small rivers or wadis feed several reservoirs in the south. A 2.0 million m^3 reservoir is under construction for irrigation and domestic use at Hobrane, which is between Al-Sweida and Salkhad. Three small reservoirs in this RPU are being used at Al-Sweida; the two larger ones were filled in 1978. No springs are reported in this RPU. The government has test wells in the RPU which have an average depth of 140 m with static level 100 m and dynamic level 122 m. Yields average 7.1 m^3/hr. These wells are in basalt formation. Small reservoirs in the south are used for domestic purposes. Statistics report some rainfed but no irrigated crop production. Prospects for future irrigation development are only small at best.

CROP RECOMMENDATIONS:

Based on climatic consideration, PPA 2-1 is of medium potential for small grains under irrigation; PPA 2-2 is of medium potential for fruit trees, olives, small grains without irrigation, and high potential with irrigation. Fruit trees and olives will yield much better if irrigation is provided.

PPA PROPERTIES	2-1	2-2
GENERAL		
elevation	600-1600 m	600-1600 m
dominant range of slope	8-15%	8-15%
portion of RPU	40%	60%
CLIMATE		
- Annual Characteristics		
average precipitation	150-300 mm# (213-258 mm)	200-500 mm# (321 mm)
average temperature	10-17°C# (14.3°C)	10-17°C#
- Wet Season Characteristics		
average monthly precipitation	> 38 mm@ (38-45 mm)	< 60 mm@ (57 mm)
average monthly temperature	7-10°C+	3-8°C+
period of wet season	November through March	November through March
SOILS		
principal components	Lithic Xerorthents, Lithic Torriorthents	Lithic Xerorthents, Lithic Torriorthents
depth to bedrock	less than 50 cm	less than 50 cm
texture	medium	medium
coarse fragments	very stony	very stony
permeability	moderate	moderate
reaction	alkaline	alkaline
salinity	nonsaline	nonsaline
available water capacity	low	low
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate to low	moderate to low
susceptibility to erosion	moderate	moderate
most intensive land use	pastureland	pastureland

RPU 3

GENERAL DESCRIPTION:

RPU 3 is an area of undulating plains with deep soils overlying basalt. Approximately 328,000 hectares are encompassed, located in the southwest part of the country north and east of Dar'a, at an elevation of 400 to 800 m.

RPU 3 is divided into two coarsely patterned PPAs on the basis of soils. The climate is fairly uniform.

PRODUCTION POTENTIAL AREAS:

PPA 3-1 is by far the more extensive, comprising approximately 90 percent of the RPU. It consists of Typic Chromoxererts on gentle slopes. They are deep, alkaline and well or moderately well drained. These are reddish heavy clay soils that are sticky and plastic when wet and hard and cloddy when dry. They are difficult to manage. However, they are productive soils where moisture supplies are adequate and good management practices are used, and would be suited for use as cropland. Mechanized farming would be feasible.

PPA 3-2 consists of three small areas of Lithic Xerorthents occurring in coarse patterns in the southern part of the RPU. They consist of shallow soils on the more sloping areas; some are medium textured and some are fine textured like those in PPA 3-1; stoniness is common. Because of shallow depths, available moisture is low. Potential for farming is low; the PPA is best suited for use as range.

In both PPAs the mean annual temperature range is 16° to 18°C. Annual precipitation ranges from 200 mm to 500 mm, with heavier precipitation in the west. During the wet season (Nov. through Mar.) the monthly precipitation ranges from 37 to 74 mm in both PPAs.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Several crops have been reported for this RPU. They are tomatoes, pistachios, grapes, grain (both wheat and barley), and melons. Eucalyptus and young olive orchards, figs, loquats, pomegranates, onions, cabbage, radish, lentils, and chickpeas have been observed.

The flora of the RPU includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora

Lactuca orientalis
Centaurea damascena
Astragalus spp.
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althaea rufescens
Onosma aleppica
Phlomis damascena

Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Salvia spinosa
Stipa parviflora
Onobrychis ptolemaica
Hyocyamus aureus
Ononis spinosa leiosperme
Hordeum spontaneum
Mirabilis jalapa
Bromus danthoniae
Cousinia aleppica
Salvia spp.
Trigonella sp.
Stipa spp.
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus
Halogeton alopecuroides
Malva aegyptiaca
Evax contracta
Filago spathula
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Tamarix spp.

WATER RESOURCES AND USES:

Reports for 1970-73 show the Yarmouk flow to average 221 million m^3 per year; recent measurements are not available. Presumably these earlier amounts were downstream from the tributaries in RPU 3.

Four government irrigation networks occur in RPU 3, which reportedly contains 8,323 hectares of irrigated land.

Three completed reservoirs for irrigation have a total capacity of 19,000,000 m^3; three smaller reservoirs are available for domestic use, total capacity 630,000 m^3. Three other reservoirs, capacity 22,100,000 m^3, are under construction for irrigation on tributaries and wadis draining into the Yarmouk River. Another reservoir under construction with a capacity of 6,600,000 m^3, while located in RPU 5, is on a tributary that is largely in RPU 3.

Of twenty-six springs with an average total flow of about 4,200 l/sec in the area, nearly all drain into the Yarmouk tributaries and in turn into the small reservoirs described above. This flow amounts to 120 million m^3 of water which is relatively a large amount for this RPU.

The reservoirs under construction are intended to irrigate about 2,400 hectares of new land (Sheik Meskine 1,500, Tsil 700, Gharieh East 200). The government also has plans for reorganization and renovation of distribution systems, especially the Mzerib Network northeast of Dar'a. One problem in the Yarmouk Basin is that small reservoirs are usually only partly filled. The government has also constructed a large number of diversion dams which divert water when it is raining and not especially needed by crops and prevent it from entering the storage reservoirs for later use.

Seventeen government test wells have an average depth of 165 m, static level of 96 m and dynamic level of 133 m. Average yield is 26.6 m^3/hr. Basalt formation is predominant although about one third of the wells are in limestone.

This RPU is the primary agricultural area of the Upper Yarmouk in Syria. It is largely cropped with a substantial amount of irrigation. Winter wheat is a prominent irrigated crop. Other irrigation is largely concentrated on summer crops including tomatoes, watermelons, maize, onions, fruits, and other vegetables.

Fruit canning is one of the heavier needs for industrial water in this RPU.

CROP RECOMMENDATIONS:

With irrigation and appropriate management practices, PPA 3-1 represents an area of high potential for the following crop groups: oil crops, small grains; and medium potential for nonrosaceous fruit trees, vegetables, olives, grapes, and pulses.

PPA 3-2 is best suited to range or natural cover, although there would be low potential for the production of olives, grapes, and certain citrus under irrigation.

PPA PROPERTIES	3-1	3-2
GENERAL		
elevation	400-800 m	400-800 m
dominant range of slope	3-8%	3-8%
portion of RPU	90%	10%
CLIMATE		
- Annual Characteristics		
average precipitation	200-500 mm# (235-400 mm)	200-500 mm# (235-400 mm)
average temperature	16-18°C# (16.8-17.6°C)	16-18°C# (16.8-17.6°C)
- Wet Season Characteristics		
average monthly precipitation	> 38 mm@ (37-74 mm)	> 38 mm@ (37-74 mm)
average monthly temperature	10-12°C+	9-12°C+
period of wet season	November through March	November through March
SOILS		
principal components	Typic Chromoxererts	Lithic Xerorthents
depth to bedrock	greater than 1 m	less than 50 cm
texture	fine	medium and fine
coarse fragments	nonstony	stony
permeability	slow	moderate
reaction	alkaline	neutral to alkaline
salinity	-	-
available water capacity	low	low
drainage class	well to somewhat poorly drained	well to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate to high	low
susceptibility to erosion	slight	slight
most intensive land use	cropland-irrigated	range

RPU 4

GENERAL DESCRIPTION:

RPU 4 consists of rolling basalt plains estimated to cover approximately 156,500 hectares in the vicinity of Al-Sweida and the foothills and plains surrounding Jebel Druze. Elevation ranges from 800 to 1510 m.

This RPU comprises a single PPA which includes a range in climate, but suffers from such poor soil conditions that the climate differences have little effect on the agricultural potential.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 12° to $16^{\circ}C$. Annual precipitation ranges from 200 mm to 400 mm. During the wet season (Nov. through Mar.) precipitation averages 38-82 mm per month. To the north, wet season precipitation may average less than 38 mm per month.

The soils in this RPU are Lithic Xerorthents, vertic phase. They are heavy clay soils less than 50 cm deep to the underlying basalt; locally, in the more level areas, the soils are slightly deeper than 50 cm. They are stony, and rubbly surfaces and rock outcrops are common throughout the PPA. The area has little potential for farming and is suited mainly for the forage afforded by the natural vegetation.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops that were reported or observed include: figs, grapes, corn, onions, olives, pistachios, citrus, and date palms.

A list of natural vegetation (either reported or observed) is given below:

Lactuca orientalis
Centaurea damascena
Achillea fragrantissima
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejek
Stachys nivea
Carthamus
Althea rufescens
Onosma aleppica
Phlomis damascena
Bromus danthoniae
Cousinia aleppica
Salvia spp.
Trigonella sp.
Astragalus tribuloides
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula

Artemisia herba-alba
Haloxylon articulatum
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stemophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus

Stipa spp.
Trigonella radiata
Hypecoum pendulum
Juniperus excelsa
Noaea mucronata
Berberis cretica
Onobrychis cornuta
Onobrychis ptolemaica
Polygonum spp.
Phlomis brevilabris
Cousinia hermonis
(Alsine =) Minuartia juniperina
Marrubium libanoticum
Potentilla geranioides
Dactylis glomerata
Eryngium heldroidhii
Ziziphora celinopodioides
Senecio doriiformis
Leontodon hispidulus
Scabiosa aucheri
Helianthemum aegyptiacum
Halogeton alopecuroides
Artemisia herba-alba
Haloxylon articulatum
Stipa parviflora
Acantholimon ulicinum
Rhamnus libanotica
Cirsium lappaceum
Poa diversifolia
Draba spp.
Morina persica
Veronica macrostachya
Asphodeline taurica
Lotus corniculatus
Melica nebrodensis

WATER RESOURCES AND USES:

Much of the land is used for rainfed crop production and no intensive agriculture is reported. Although a reservoir (19,500,000 m^3 capacity) has been constructed in the upper eastern portion of the RPU, no water was stored in 1978 since distribution canals were not completed. It appears that irrigation is at least intended here, though exactly where is not clear. If filled, the reservoir could store water for about 2,000 hectares.

The other sizeable reservoir (4,600,000 m^3 capacity) was constructed near Al-Sweida for domestic purposes and was filled to 82 percent of capacity in 1978. No springs are shown for this RPU, probably an indication of its aridity. Five test wells north of Al-Sweida have an average depth of 205 m, static level of 89 m and dynamic level of 202 m with an average yield of 10.8 m^3 hr. All wells are in basalt formation.

CROP RECOMMENDATIONS:

RPU 4 has insignificant agricultural potential. Some citrus and fruit trees could be grown with irrigation where soil depth is adequate. Expectations would indicate relatively low yields, however.

PPA PROPERTIES	4-1
GENERAL	
elevation	800-950 m
dominant range of slope	8-15%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	200-400 mm#
average temperature	12-16°C#
- Wet Season Characteristics	
average monthly precipitation	< to > 38 mm@ (38-82 mm)
average monthly temperature	5-11°C+
period of wet season	November through March
SOILS	
principal components	Lithic Xerorthents, vertic phase
depth to bedrock	less than 50 cm
texture	fine
coarse fragments	stony, rubbly
permeability	slow, and very slow
reaction	alkaline
salinity	-
available water capacity	low
drainage class	well to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low
susceptibility to erosion	moderate to low
most intensive land use	rangeland

RPU 5

GENERAL DESCRIPTION:

RPU 5 is an area of undulating to strongly rolling basalt plains. It is located along the southwest border of the country and has an area of approximately 183,400 hectares. Elevation ranges from 500 to 1200 m. The mean annual temperature range is 15^{o} to $18^{o}C$. Annual precipitation ranges from 500 mm to 1,000 mm.

PRODUCTION POTENTIAL AREAS:

Six coarsely patterned PPAs occur in RPU 5.

PPA 5-1's climate is characterized by an annual precipitation of less than 500 mm. During the wet season (Nov. through Mar.) the monthly precipitation averages are usually above 38 mm.

In PPA 5-2 the annual precipitation averages 500-1,000 mm. During the wet season (Nov. through Mar.) monthly precipitation averages greater than 90 mm. The PPA is located in south central RPU 5.

PPA 5-3 receives annually between 750-1000 mm of precipitation. During the wet season (Nov. through Mar.) the average monthly precipitation exceeds 125 mm.

PPAs 5-1, 5-2, and 5-3 consist of the undulating plains in the eastern part of the RPU. The soils are Typic Pelloxererts, deep dark colored alkaline clays, commonly with stony surfaces. They are slowly to very slowly permeable and are sticky and plastic when wet and hard and cloddy when dry. These are productive soils but are difficult to manage because of the high clay content and in some places because of stones. These PPAs are suited for use as cropland but irrigation would be required for optimum yields.

PPAs 5-4, 5-5, and 5-6 differ from PPAs 5-1, 5-2, and 5-3 only on the basis of soil characteristics.

They comprise the more sloping western part of the RPU. The soils are similar to those in PPAs 5-1, 5-2 and 5-3 but are not as deep to the underlying rock, are more stony, and have a slightly lower moisture holding capacity. These are also productive soils but a higher level of management, to include erosion control and less intensive cropping, would be needed for optimum yields.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Grain (barley and wheat), fruit trees, grapes, figs, pomegranates, eucalyptus, and poplars were observed or reported. Not all occurred on a commerical scale.

Some of the vegetation reported or seen:

Rotama duriaci
Linaria palaestina
Ziziphus spina-christi
Salsola vermiculata
Atriplex halimus
Varthemia iphionoides

Astragalus spinosa
Thymus syriacus
Noaea mucronata
Hordeum bulbosum
Dactylis hispanica
Bromus danthoniae

Ferula communis
Cenchrus ciliaris
Salvia dominica
Morus sp.
Rumex sp.
Motucella sp.
Tamarix sp.
Segamum sp.
Pistacia palaestina
Quercus calliprinos
Olea europaea
Hyparrhonia hirta
Urginea maritima
Lolium sp.

Cousinia spp.
Centaurea spp.
Anchusa spp.
Alkanna spp.
Phlomis sp.
Onoperdon anisacanthum
Salvia spp.
Phalaris spp.
Silene coniflora
Echinops blanchaenus
Hypericum triquetrifolium
Euphorbia spp.
Prosopis sp.

WATER RESOURCES AND USES:

At present, rainfed crops are relatively prominent and only 1,000 hectares of irrigated crops are reported. Proposals for future irrigation development are meagre. One small reservoir near Quneitra for irrigation and domestic use was filled in 1978. Another small reservoir nearby is under construction. The latter reservoir (6,6728,000 m^3 capacity) is intended for irrigation but is actually located in the RPU 3 drainage area. Fourteen springs are located in the RPU, mostly in the north central portion. The average annual flow is about 14 million m^3; the use of this water is not known. Three canals are inventoried in the vicinity of Quneitra, all spring fed. Beida spring (40 hectares), Fawar spring (170 hectares), and a group of springs (250 hectares) are involved with these three canals. Two government test wells are located within RPU 5, but these are also in the RPU 3 drainage area. Average depth is 128 m. Static level of water is 67 m; dynamic level is not available. Pumps are small and yield only 3.4 m^3/hr. Both wells are in basalt formation.

CROP RECOMMENDATIONS:

RPU 5 varies greatly in climate, in part because of topography, becoming relatively moist at higher elevations (PPA 5-3). For the major crops under consideration at this time, the PPAs may be discussed under two headings.

First, PPAs 5-1, 5-2, and 5-3 all have relatively deep soils and differ from each other largely in rainfall. PPA 5-1 is ill-suited to rainfed agriculture, but with irrigation has virtually the same potential as PPAs 5-2 and 5-3. Under irrigation, production potential in PPAs 5-2 and 5-3 would be high for small grains, pulses, some vegetables, fruit trees, grapes, and oil crops. Without irrigation, PPA 5-2 could be rated of medium potential for small grains, grapes and some pulses and oil crops, while PPA 5-3 can be rated medium for those crops, and fruit trees.

Second, 5-4, 5-5, and 5-6 display the same climatic range, but over soils less deep than those in PPAs 5-1, 5-2, and 5-3. As noted elsewhere this means that more intensive management will be required. The potentials for the various crops would otherwise be the same, that is, potentials for PPA 5-4 match those for PPA 5-1, 5-5 matches 5-2, and 5-6 matches 5-3.

PPA PROPERTIES	5-1	5-2	5-3
GENERAL			
elevation	500-1200 m	500-1200 m	500-1200 m
dominant range of slope	3-8%	3-8%	3-8%
portion of RPU	17%	17%	17%
CLIMATE			
- Annual Characteristics			
average precipitation	500-1,000 mm#	500-1,000 mm#	500-1,000 mm# (794-823 mm)
average temperature	15-18°C#	15-18°C#	15-18°C#
- Wet Season Characteristics			
average monthly precipitation	> 38 mm@	> 90 mm@	> 125 mm@ (142 mm)
average monthly temperature	5-9°C+	9-13°C+	8-13°C+
period of wet season	November through March	November through March	November through March
SOILS			
principal components	Typic Pelloxererts	Typic Pelloxererts	Typic Pelloxererts
depth to bedrock	greater than 1 m	greater than 1 m	greater than 1 m
texture	fine	fine	fine
coarse fragments	stony	stony	stony
permeability	slow to very slow	slow to very slow	slow to very slow
reaction	alkaline	alkaline	alkaline
salinity	nonsaline	nonsaline	nonsaline
available water capacity	low	low	low
drainage class	moderately well to somewhat poorly drained	moderately well to somewhat poorly drained	moderately well to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate	moderate	moderate
susceptibility to erosion	low	low	low
most intensive land use	cropland	cropland	cropland

PPA PROPERTIES	5-4	5-5	5-6
GENERAL			
elevation	500-1200 m	500-1200 m	500-1200 m
dominant range of slope	8-15%	8-15%	8-15%
portion of RPU	17%	17%	15%
CLIMATE			
- Annual Characteristics			
average precipitation	500-1,000 mm#	500-1,000 mm#	500-1,000 mm# (794-823 mm)
average temperature	15-18°C#	15-18°C#	15-18°C#
- Wet Season Characteristics			
average monthly precipitation	> 38 mm@	> 90 mm@	> 125 mm@ (142 mm)
average monthly temperature	5-9°C+	9-13°C+	8-13°C+
period of wet season	November through March	November through March	November through March
SOILS			
principal components	Typic Pelloxererts	Typic Pelloxererts	Typic Pelloxererts
depth to bedrock	50-100 cm	50-100 cm	50-100 cm
texture	fine	fine	fine
coarse fragments	stony, rubbly	stony, rubbly	stony, rubbly
permeability	slow to very slow	slow to very slow	slow to very slow
reaction	alkaline	alkaline	alkaline
salinity	nonsaline	nonsaline	nonsaline
available water capacity	low	low	low
drainage class	moderately well to somewhat poorly drained	moderately well to somewhat poorly drained	moderately well to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate to low	moderate to low	moderate to low
susceptibility to erosion	moderate	moderate	moderate
most intensive land use	cropland (forage, pasture)	cropland (forage, pasture)	cropland (forage, pasture)

RPU 6

GENERAL DESCRIPTION:

RPU 6 is an area of dissected slopes associated with drainage leading from the higher lying basalt plateau (RPU 5) into Lake Tiberius along the southwestern border of Syria. It covers an area of about 57,000 hectares. Elevation ranges from below sea level to 350 m. The mean annual temperature range is from 17° to 19°C. Annual precipitation ranges from 400 mm to 600 mm.

RPU 6 is divided into two coarsely patterned PPAs on the basis of climate.

PRODUCTION POTENTIAL AREAS:

PPA 6-1 occupies all but the eastern portion of RPU 6. The climate characterized by 400-500 mm of precipitation annually. During the wet season (Nov. through Mar.) the average monthly precipitation is 85 mm. Frost has not been recorded.

PPA 6-2 is in the eastern part of RPU 6. The climate has an average annual precipitation of 400-600 mm. The average monthly precipitation during the wet season (Nov. through Mar.) exceeds 90 mm.

The soils in both PPAs are Lithic Xerochrepts, very shallow, slightly sloping, medium and fine textured, and stony; areas of rock outcrops are common. The RPU is generally unsuited for any agricultural use because of the steep slopes in combination with stoniness and low moisture holding capacity. Some local use as cropland would be feasible on interfluves, where the soils are somewhat deeper and less stony.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops that were either reported or observed were: olives, figs, citrus, poplars, and eucalyptus.

The vegetation either reported or seen included:

Pistacia palaestina	Quercus calliprinos
Olea europaea	Hyparrhenia hirta
Urginea maritima	Opuntia sp.
Nerium oleander	Sesamum sp.

WATER RESOURCES AND USES:

Soils are poor but some crop production, mostly rainfed, occurs. It is bordered by the Yarmouk on the south, and at least one tributary is in the area. No reservoirs, springs, or government test wells are shown for this RPU. No irrigated crop production is reported and apparently there will be no irrigation development in the future.

CROP RECOMMENDATIONS:

The agricultural potential for both PPAs in RPU 6 is generally insignificant. Low yields could be expected under irrigation for small grains, rosaceous and nonrosaceous fruit trees, pulses, vegetables, and citrus in limited areas of each PPA if irrigation

were possible. In PPA 6-2 the same crop groups would be expected to have relatively low yield potential under rainfed production in those areas where cultivation would be feasible.

PPA PROPERTIES	6-1	6-2
GENERAL		
elevation	below sea level-350 m	below sea level 350 m
dominant range of slope	more than 25%	more than 25%
portion of RPU	70%	30%
CLIMATE		
- Annual Characteristics		
average precipitation	400-500 mm# (476-486 mm)	400-600 mm#
average temperature	17-19°C# (18.8°C)	17-19°C#
- Wet Season Characteristics		
average monthly precipitation	> 60 mm@ (85 mm)	> 90 mm@
average monthly temperature	12-14°C+	11-13°C+
period of wet season	November through March	November through March
SOILS		
principal components	Lithic Xerochrepts	Lithic Xerochrepts
depth to bedrock	less than 50 cm	less than 50 cm
texture	medium to fine	medium to fine
coarse fragments	stony; rock outcrops	stony; rock outcrops
permeability	moderate	moderate
reaction	alkaline	alkaline
salinity	nonsaline	nonsaline
available water capacity	low	low
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	low	low
susceptibility to erosion	high	high
most intensive land use	woodland	woodland

RPU 7

GENERAL DESCRIPTION:

RPU 7 consists of the desertic southwest limestone plateau and comprises 2,407,800 hectares, nearly ten percent of the country. Elevations range from 600 to 1000 m. The mean annual temperature range is 17° to 20°C. Annual precipitation ranges from 50 mm to 150 mm.

RPU 7 has been divided into three coarsely patterned PPAs on the basis of differences in soils.

PRODUCTION POTENTIAL AREAS:

PPA 7-1 consists of the highly calcareous Typic Calciorthids, mostly on undulating plains. They are moderately deep soils (commonly less than 1 m deep), medium textured, and highly calcereous. Associated with these soils are Typic Torriorthents on level areas; these are somewhat deeper soils, generally sandy and flint-strewn, although in the northwestern part of the area some are stony, and also calcareous. The soils in this PPA would be of low to moderate potential productivity if water for irrigation were available and used under careful management. However, in their natural state they are suited for use as rangeland.

PPA 7-2 consists of nearly level and rolling limestone plains. The soils, Lithic Calciorthids, are shallow to bedrock, medium to fine textured, and stony; they are highly calcareous and slightly saline. These soils are of low productivity and not suited for agricultural use because of low rainfall and limited moisture-holding capacity and rooting depth. They are best used as rangeland.

PPA 7-3 comprises the strongly rolling to steep Lithic Camborthids and Lithic Torriorthents. These are shallow and very shallow stony soils overlying basalt and limestone and are too steep and too stony to be used for farming.

Because the RPU extends over a significant range in latitude, average annual temperatures in the south are slightly warmer than those dominant in most of the RPU. This broader range in temperature has little effect on the potential for crop production because the scarcity or lack of water required to produce a crop is controlling. During the wet season (Oct. through May) the average monthly precipitation is about 13 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

No crops have been reported for this RPU.

A vegetation list follows:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa

Tamarix spp.
Frankenia spp.
Halocnemum strobilaceum
Salicornia herbacea
Salsola crassa
Statice palmyrensis
Aelurepus littoralis
Sphenopus divaricatus

Adonis dentata
Spergularia diandra
Senecio desfontainei
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Filago spathula
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Leontodon hispidulus
Schismus arabicus
Juncus maritimus
Salsola inermis
Plantago notata
Salvia spinosa
Malva aegyptiaca
Evax contracta
Poa sinaica
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Halogeton alopecuroides
Stipa parviflora
Onobrychis ptolemaica
Scabiosa aucheri
Helianthemum aegyptiacum

WATER RESOURCES AND USES:

A large portion of the soils are suitable for irrigation but there is no prospect of water for further irrigation. Crop production of any kind is meagre. Two small reservoirs were constructed in the area. Neither contained any water in 1978, though their capacity is 3.355 million m^3. Three other reservoirs are proposed for construction by 1981 and their anticipated capacity is 10.5 million m^3. All reservoirs are for domestic and livestock use.

No springs are shown for this RPU. The government has installed a substantial number of wells for livestock and domestic use. Fourteen of these wells are in the study sample. The average depth is 274 m, static water level is 112 m and dynamic level is 157 m. Yields are relatively small, only 5.3 m^3/hr. Most wells are in basalt formation or basalt - marls.

Neither rainfed nor irrigated crop production is reported although vast areas of soil are suitable.

CROP RECOMMENDATIONS:

RPU 7 is a desert, divided into three PPAs on the basis of soil characteristics. Since there is no question of raising major crops in a climate like this without irrigation, the question of crop adaptability becomes one of soil characteristics. PPAs 7-2 and 7-3 contain mostly soils whose low productive capacities would not be enhanced by irrigation. The soils of PPA 7-1, however, may be rated as having medium potential for small grains, oil crops, tuber/bulb crops, and cotton under irrigation.

PPA PROPERTIES	7-1	7-2	7-3
GENERAL			
elevation	600-750 m	600-750 m	700-1000 m
dominant range of slope	0-8%	3-8%	8 to more than 25%
portion of RPU	70%	20%	10%
CLIMATE			
- Annual Characteristics			
average precipitation	50-150 mm# (107 mm)	50-150 mm# (107 mm)	50-150 mm# (107 mm)
average temperature	17-20^{o}C# (17.7^{o}C)	17-20^{o}C# (17.7^{o}C)	17-20^{o}C# (17.7^{o}C)
- Wet Season Characteristics			
average monthly precipitation	< 38 mm@ (13 mm)	< 38 mm@ (13 mm)	< 38 mm@ (13 mm)
average monthly temperature	13-15^{o}C^{+}	10-15^{o}C^{+}	10-15^{o}C^{+}
period of wet season	October through May	October through May	October through May
SOILS			
principal components	Typic Calciorthids Typic Torriorthents	Lithic Calciorthids	Lithic Camborthids Lithic Torriorthents
depth to bedrock	greater than 50 cm	less than 50 cm	less than 25 cm
texture	medium to coarse	medium to fine	medium
coarse fragments	nonstony	nonstony	stony
permeability	moderate	moderate	moderate
reaction	highly alkaline	alkaline	alkaline
salinity	slightly saline	-	-
available water capacity	low to moderate	low	low
drainage class	well drained	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate to low	low	low
susceptibility to erosion	low	low	high
most intensive land use	cropland, irrigated	rangeland	rangeland

RPU 8

GENERAL DESCRIPTION:

RPU 8 is an undulating basalt plain interrupted by low hills situated south of Damascus. It is estimated to be approximately 94,000 hectares in extent. Elevations range from 600-1100 m. Annual precipitation ranges from 100 mm to 250 mm.

RPU 8 is divided into two coarsely patterned PPAs on the basis of soils and topography. The climate is relatively uniform throughout the RPU.

PRODUCTION POTENTIAL AREAS:

PPA 8-1 consists of undulating basalt plains. The soils are Typic Chromoxererts. They are deep, dark reddish alkaline clays having low rates of permeability and are sticky and plastic when wet and hard and widely cracked when dry. These are moderately productive soils and suited for use as cropland although management would be difficult.

PPA 8-2 consists of low basalt hills on which the soils are Lithic Xerorthents, vertic phase. These soils are similar to those on the surrounding plains except that they are less than 50 cm deep to bedrock and are very stony. Because of the combination of strong slopes, stoniness, and shallowness, they are generally unsuited for agricultural use except for the grazing afforded by native vegetation.

The climate in PPA 8-1 is characterized by an annual temperature of 16-20°C. The average annual temperature in PPA 8-2 is 16-18°C. During the wet season (Oct. through May) the average monthly precipitation is about 16 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Wheat, barley, and irrigated sugar beets are some of the crops observed or reported in this RPU. Other crops seen include cotton, cabbage, corn, onions, grapes, figs, olives, lettuce, eucalyptus, and poplar.

A list of vegetation seen or reported included:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Salsola vermiculata
Peganum harmala
Salvia lanigera
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Spergularia diandra
Anabasis aphylla
Haloxylon articulatum
Peganum harmala
Erodium pulverulentum
Poa sinaica
Astragalus tribuloides
Anthemis deserti-syriaci

Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Malcomia torulosa
Leontodon hispidulus

WATER RESOURCES AND USES:

This RPU is in the Horan and Damascus hydro subbasins, mostly in the latter. It apparently includes a substantial portion of the A'waj River Basin and the southern portion of Irrigation Network 7.

The A'waj gauging station upstream from RPU 8 showed an annual flow of 157 million m^3. One reservoir, Awra, with capacity of 2 million m^3 is proposed for construction by 1981. It would be used for irrigation and domestic purposes. No springs are recorded for this RPU, but there are a large number of springs in the upper A'waj drainage.

Sixteen test wells average 116 m in depth, with a static level of 14 m and a dynamic level of 28 m. Yields are relatively large -- 25.6 m^3/hr. Three Water Basin Administration wells average 302 m deep with static level 22 m and dynamic level 73 m. Only one WBA well was tested and its yield was only 0.7 m^3/hr. Most wells in this RPU are in basalt formation although several were basalt - sand. Substantially more irrigated area than currently shown should be possible if A'waj waters could all be utilized effectively. The conjunctive use of surface and ground waters should be a careful consideration in this RPU.

CROP RECOMMENDATIONS:

RPU 8 has a relatively homogeneous dry climate generally unsuited for rainfed agriculture. PPA 8-2 is unsuitable for either irrigated or rainfed agriculture because of soil characteristics. PPA 8-1, with proper management practices including irrigation, has high potential for small grains, olives, fruit trees, grapes, cotton, pulses, tuber/bulb crops, and oil crops, and medium for vegetables.

PPA PROPERTIES	8-1	8-2
GENERAL		
elevation	600-700 m	700-1100 m
dominant range of slope	0-8%	20-30%
portion of RPU	75%	25%
CLIMATE		
- Annual Characteristics		
average precipitation	100-250 mm# (126 mm)	100-250 mm# (126 mm)
average temperature	16-20°C#	16-18°C#
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@ (16 mm)	< 38 mm@ (16 mm)
average monthly temperature	12-14°C+	12-14°C+
period of wet season	October through May	October through May
SOILS		
principal components	Typic Chromoxererts	Lithic Xerorthents, vertic phase
depth to bedrock	greater than 1.5 m	less than 50 cm
texture	fine	fine
coarse fragments	nonstony	stony
permeability	slow	slow
reaction	alkaline	alkaline
salinity	-	-
available water capacity	low	low
drainage class	well and moderately well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate to high	low
susceptibility to erosion	low	high
most intensive land use	cropland, irrigated	rangeland

RPU 9

GENERAL DESCRIPTION:

RPU 9 is a nearly level plain west and north of Damascus adjoining the steep slopes of the Jebel esh Sharqi and the Jebel Maa'lula. Underlying strata consist of limestone conglomerate. Elevation ranges from 750-1900 m. The RPU encompasses an area of approximately 163,500 hectares. Annual precipitation ranges from 100 mm to 250 mm.

The RPU is divided into four coarsely patterned PPAs on the basis of marked differences in topography and in climate.

PRODUCTION POTENTIAL AREAS:

PPA 9-1 comprises about 45 percent of the RPU. The soils are Typic Xerorthents, stony soils of various depths overlying the limestone conglomerate. They are well drained, medium textured, and moderately to rapidly permeable; the soils are mildly alkaline. Available moisture is limited not only by the climate but also by the relatively shallow depth of soil over the coarse stony substratum. The soils are moderately productive and would be suited for use as cropland particularly for less intensively cultivated crops where stoniness is not severe and water for irrigation could be made available. The climate is characterized by an average annual temperature between 10 and 14°C. PPA 9-1 has a wet season (November through April) with an average monthly precipitation of less than 38 mm.

PPA 9-2 is equal in extent to PPA 9-1 and has soils which are similar to those described under PPA 9-1. The climate is characterized by an average annual temperature range from 10 to 14°C. During the wet season (Nov. through April) the average monthly precipitation averages 44-47 mm.

PPA 9-3 comprises about 5 percent of the RPU. It consists of Lithic Xerochrepts on elongated hilly ridges mainly in the northern part of the RPU. These soils are stony and shallow to the underlying limestone; outcrops of bedrock are common. Because of steepness, shallowness, and stoniness of the soils, this PPA has little potential for agriculture. It is best suited for use as grazing land for the browse afforded by the native grasses and shrubs. The climate is characterized by an average annual temperature of 10-12°C. PPA 9-3 has a wet season (Nov. through April) with an average monthly precipitation of less than 38 mm.

PPA 9-4 comprises the remaining 5 percent of the RPU. Its soils are the same as those described under PPA 9-3. The climate is characterized by an average annual temperature of 10-12°C. During the wet season (Nov. through April) the average monthly precipitation averages 44-47 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

The reported crops for this RPU are almonds, fruit, and grapes. Other crops include corn, cabbage, beans, figs, citrus, radishes, cauliflower, artichoke, wheat, barley, olive, pistachio, eucalyptus, and poplars. Both lettuce and corn were intercropped with olives.

The flora of RPU 9 includes the following list of plants:

Lactuca orientalis
Centaurea damascena
Astragalus spp.
Noaea mucronata
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althaea rufescens
Onosma aleppica
Phlomis damascena
Bromus danthoniae
Cousinia aleppica
Salvia spp.
Trigonella sp.
Parthenocissus sp.
Crocus sp.
Haloxylon articulatum
Achillea fragrantissima
Scabiosa aucheri
Ephedrda alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Astragalus tribuloides
Anthemis deserti-syriaci
Malcomia torulosa
Trifolium sp.
Medicago sp.
Vicia sp.
Lotus sp.
Scorpiurus sp.
Lathyrus sp.
Ononis sp.
Poa bulbosa
Hordeum bulbosum
Dactylis hispanica
Nerium oleander
Laurus nobilis
Salix sp.
Sophora sp.
Platnus orientalis
Fraxinus sp.
Stipa sp.
Bougainvillea sp.
Arbutus sp.
Artemesia herba-alba
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Hordeum sp.
Amygdalus sp.
Papaver sp.
Anabasis aphylla
Leontodon hispidulus
Peganum harmala
Poa sinaica
Salvia lanigera
Arnebia decumbens
Schismus arabicus

WATER RESOURCES AND USES:

No reservoirs are present but several have been proposed in the area which may serve this RPU.

Twenty-four springs with total flows of more than 4,000 l/sec or 125 million m^3 annually, are listed. Two especially large springs, Al-Figeh and Barada, are on the Barada River upstream from this RPU; their combined flows are more than 11,000 l/sec. The annual stream flow of the Barada River, upstream from Damascus before canal diversions but after diversion of Damascus City water supply, is about 250 million m^3. A portion of Irrigation Network 7 is in this RPU. The Western Ghouta lists 29 canals; their locations are not entirely identified, but they appear to involve RPUs 8, 9, and 10. At least nine of these canals are identified with springs. Apparently the canals serve lands in both Barada and A'waj basins. Because of

Damascus sewage, the quality of water in the Barada is extremely low and a treatment plant is planned.

A large number of wells have been installed, including twelve wells averaging 174 m deep with static level of 34 m and dynamic level of 39 m. Yields averaged 31.6 m^3/hr. The eight Water Basin Administration wells were somewhat deeper -- 276 m with static level at 50 m and dynamic level at 69 m; but the yields were much smaller --5.0 m^3/hr per well. The test wells were in a wide variety of formations -- limestone, marls, sand.

The Damascus City Mohafaza, which is in this RPU, reports about 2,000 hectares of irrigated crops; there are no nonirrigated crops. The irrigated cropland use-intensity ratio is 130. Both winter and summer vegetables and fruits are the main crops. Apparently a common practice is to grow two or three vegetables on the same land at the same time. The Mohafaza is also a large producer of livestock.

Damascus City's domestic and industrial uses of water reportedly total 94.5 million m^3 per year, with capacity to be increased to 163.8 million m^3 per year. The Barada River, including return flows, provides water for downstream uses and recharge of the aquifers for thousands of wells used for domestic and agricultural purposes.

CROP RECOMMENDATIONS:

RPU 9 is characterized by a dry climate, varying slightly so that PPA 9-2 and PPA 9-4 have a somewhat more intense rainy season than in PPAs 9-1 and 9-3. Major crops would not be expected to respond much differently in PPAs 9-1 and 9-2, which have high potential for fruit trees, olives, grapes, vegetables, and small grains under irrigation. PPAs 9-3 and 9-4 have virtually no potential for production of cultivated crops.

PPA PROPERTIES	9-1	9-2	9-3	9-4
GENERAL				
elevation	750-1800 m	750-1800 m	1450-1900 m	1450-1900 m
dominant range of slope	0-3%	0-3%	20-30%	20-30%
portion of RPU	45%	45%	5%	5%
CLIMATE				
- Annual Characteristics				
average precipitation	100-250 mm# (128-225 mm)	100-250 mm#	100-250 mm# (128-225 mm)	100-250 mm#
average temperature	10-14°C#	10-14°C#	10-12°C#	10-12°C#
- Wet Season Characteristics				
average monthly precipitation	< 38 mm@ (16-36 mm)	> 38 mm@ (44-47 mm)	< 38 mm@ (16-36 mm)	> 38 mm@ (44-47 mm)
average monthly temperature	4-12°C+	4-12°C+	3-8°C+	3-8°C+
period of wet season	November through April	November through April	November through April	November through April
SOILS				
principal components	Typic Xerothents	Typic Xerorthents	Lithic Xerochrepts	Lithic Xerochrepts
depth to bedrock	greater than 1 m	greater than 1 m	less than 50 cm	less than 50 cm
texture	medium	medium	medium	medium
coarse fragments	stony	stony	stony	stony
permeability	moderate	moderate	moderate	moderate
reaction	alkaline	alkaline	alkaline	alkaline
salinity	-	-	-	-
available water capacity	moderate	moderate	low	low
drainage class	well drained	well drained	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE				
inherent productive capacity	moderate	moderate	low	low
susceptibility to erosion	low	low	high	high
most intensive land use	cropland	cropland	rangeland	rangeland

RPU 10

GENERAL DESCRIPTION:

RPU 10 is a nearly level plain with seasonally high groundwater. It is east of Damascus and has an area of 68,400 hectares. Elevation is 600 m.

The RPU is uniform throughout and comprises a single PPA.

PRODUCTION POTENTIAL AREAS:

The soils are Aeric Haplaquepts that are moderately well to somewhat poorly drained, moderately fine textured, and deep over the underlying marl and soft limestone. They are moderately slowly permeable, and available moisture capacity is moderate. The soils are mildly alkaline and in some parts of the PPA they are slightly saline. The PPA is potentially moderately productive and suited for use as cropland. However, careful management in the use of irrigation and drainage to maintain proper moisture balance would be necessary to assure optimum yields and at the same time prevent development of toxic levels of salinity.

The mean annual temperature range is 16^{o} to 18^{o}C. Annual precipitation ranges from 100 mm to 200 mm. During the wet season (Nov. through April) the average monthly precipitation is less than 38 mm.

REPORTED AND OBSERVED CROPS AND VEGETATION:

Crops reported to grow in this RPU are irrigated fruit trees, Diplotaxis erucoides (L.) D.C., sugar beets, cotton, vegetables, and poplars. Additional crops observed include corn, faba beans, cabbage, grapes, tomatoes, radishes, cauliflower, sunflowers, and figs.

A list of the vegetation (reported and observed) for this RPU is below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Anabasis aphylla
Peganum harmala
Phoenix dactylifera
Morus sp.
Laurus nobilis
Rubus sanctus
Stylosanthus sp.
Tamarix spp.
Frankenia spp.
Halocnemum strobilanceum
Salicornia herbacea
Salsola crassa
Statice palmyrensis

Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Scabiosa aucheri
Aelurepus littoralis
Sphenopus divaricatus
Juncus maritimus

WATER RESOURCES AND USES:

This RPU includes the eastern portion of the Ghouta and the lower drainages of the Barada and A'waj Rivers. It is used extensively for irrigated crop production. However, stream flows of the two rivers are largely diverted and used before reaching this lower area and water supply is from return flows, wells, and springs. No reservoirs are located in this RPU. Thirteen springs are identified but stream flows are not available except for one at 300 l/sec. It may be that the others have very small flows.

A portion of Irrigation Network 7 is in this RPU. The Zone of Duma, which is also partly in RPU 9, lists 19 canals. Thirteen of these canals relate to springs; presumably the others are diversions from stream channels; most or all probably receive some water from wells. The Easter Ghouta is also generally in RPUs 9 and 10; nine canals are listed, all identified with springs.

The RPU includes both government test and Water Basin Administration wells. The test wells average 133 m in depth; static level 18 m and dynamic level 41 m. Average yield per well was 25.6 m^3/hr. The six WBA wells were similar in depth (122 m), and static levels of 33 m; all wells were not reported for dynamic level. Average yield of these wells was only 11.0 m^3/hr. Test wells were mostly in limestone formation. Water is diverted from the Barada River upstream from Damascus to six canals whose flow ranges fro 1.5 m^3/sec to 4.0 m^3/sec.

Probably most of the irrigated crops in the Duma Mantika are in this RPU. The statistics show 23,751 hectares of irrigated crops. The conjunctive use of surface water, wells, and springs is highly important in this RPU, RPU 9 and other upstream RPUs. The thousands of small, inefficient wells and pumps now in use could be replaced by a few larger, efficient units, but this would be a mammoth undertaking.

CROP RECOMMENDATIONS:

RPU 10 (consisting of a single PPA) has high production potential (under irrigation) for small grains, pulses, and nonrosaceous fruit trees, and medium potential for olives, cotton, tuber/bulb crops, grapes, and vegetables. Without irrigation it has medium potential for some pulses.

PPA PROPERTIES	10-1
GENERAL	
elevation	600 m
dominant range of slope	0-3%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	100-250 mm# (136-167 mm)
average temperature	16-18°C# (16.4-16.9°C)
- Wet Season Characteristics	
average monthly precipitation	< 38 mm@ (19-24 mm)
average monthly temperature	9-11°C+
period of wet season	November through April
SOILS	
principal components	Aeric Haplaquepts
depth to bedrock	greater than 1 m
texture	medium
coarse fragments	nonstony
permeability	moderately slow
reaction	alkaline
salinity	nonsaline to slightly saline
available water capacity	moderate
drainage class	moderately well to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	moderate
susceptibility to erosion	low
most intensive land use	cropland (irrigated and drained)

RPU 13

GENERAL DESCRIPTION:

RPU 13 is an area of 289,400 hectares of steep limestone ridges and intervening gently sloping areas of deep desert outwash located northeast of Damascus. Elevations range from approximately 800-1900 m.

RPU 13 has two coarsely patterned PPAs characterized by differences in soils and topography.

PRODUCTION POTENTIAL AREAS:

PPA 13-1 is the nearly level to undulating plain which comprises about 60 percent of the RPU. The soils are Typic Torriorthents ranging in texture from medium to coarse and generally stone-free. They are moderately deep, and deep, the lesser depths occurring in proximity to the limestone ridges of PPA 13-2. The soils are well drained, moderately to rapidly permeable and have moderate to low available moisture capacities. Some areas are slightly saline. The PPA would be suited for use as cropland if water for irrigation were made available and carefully managed to preclude any increase in levels of salinity. Without irrigation the PPA is suited for use as rangeland.

PPA 13-2 consists of a series of northeast-southwest trending hills and ridges. The soils are Lithic Camborthids - very shallow, stony, steeply sloping soils; areas of limestone bedrock exposures are common. The PPA has no potential for agricultural use except as rangeland.

The climate is mild and dry, usually being hot in the summer and cool in the winter wet season. The mean annual temperature range is 13^{o} to 16^{o}C. Annual precipitation ranges from 100 mm to 150 mm. In the southern part of the RPU average annual temperatures are slightly higher. During the wet season (Oct. through May) the average monthly precipitation is less than 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

A variety of crops have been reported for this RPU. They include potato, tomato, peas, beans, pistachio, figs, olives, corn, grapes, cabbage, sunflowers, wheat, fruit trees, chickpeas, barley, garden peas, and poplars.

The vegetation is varied and, in part, is reported below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Anabasis aphylla
Peganum harmala
Centaurea spp.
Agropyron libanoticum

Plantago notata
Silene coniflora
Erodium pulverulentum
Poa sinaica
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Arrhena therum kotschyi
Cytisus crotalarioides
Salsola vermiculata
Astragalus tribuloides
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus

WATER RESOURCES AND USES:

This RPU is mostly in hydro subbasin 13. About 60 percent of the land area is suitable for irrigated crops but water prospects are meagre. Al-Quteifeh Mantika, which is in this arid RPU, shows only 2,894 hectares of irrigated crops. Two small reservoirs - 500,000 m^3 and 2,150,000 m^3 - are in the RPU. The larger is intended for irrigation and the smaller for irrigation and domestic use. No storage in either reservoir was reported for 1978. Data shows eight small springs; total flows for the four shown are only 61 l/sec.

This study includes seven government test wells and three Water Basin Administration wells. The test wells average 239 m in depth with static level 40 m and dynamic water level 91 m. Yields of these wells averaged 14.8 m^3/hr. The wells are basically in limestone formation. The WBA wells were 256 m deep with static level at 100 m; the dynamic level was available for only one well and its yield was small -- 3.2 m^3/hr.

CROP RECOMMENDATIONS:

RPU 13 is uniformly dry, with a gradation of temperature from nominally subtropical to nominally temperate. Soils and topography sharply differentiate the two PPAs with regard to agricultural potential. PPA 13-1 is an irrigable area; with irrigation it would have high potential for production of some nonrosaceous fruit trees and some vegetables, and medium potential for small grains (especially barley), cotton, tuber/ root crops, olives, and pulses. PPA 13-2 has no potential for production of cultivated crops.

PPA PROPERTIES	13-1	13-2
GENERAL		
elevation	800-1000 m	900-1900 m
dominant range of slope	0-3%	20-35%
portion of RPU	60%	40%
CLIMATE		
- Annual Characteristics		
average precipitation	100-150 mm# (129 mm)	100-150 mm# (129 mm)
average temperature	13-16^{o}C#	13-16^{o}C#
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@ (16 mm)	< 38 mm@ (16 mm)
average monthly temperature	10-13^{o}C^{+}	8-13^{o}C^{+}
period of wet season	October through May	October through May
SOILS		
principal components	Typic Torriorthents	Lithic Camborthids
depth to bedrock	greater than 50 cm	less than 50 cm
texture	medium to coarse	medium
coarse fragments	stone free	stony
permeability	medium to rapid	rapid
reaction	alkaline	alkaline
salinity	slightly saline	-
available water capacity	moderate to low	low
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate to low	low
susceptibility to erosion	low	high
most intensive land use	cropland-irrigated	rangeland

RPU 15

GENERAL DESCRIPTION:

RPU 15 consists of the summit and eastern slopes of the Jebel esh Sharqi and the Jebel Maa'lula generally west and north of Damascus, an area of approximately 150,100 hectares. Elevations range from 1200-2600 m.

The soils of the RPU are generally uniform and although the climate varies greatly with respect to precipitation, RPU 15 has not been divided into PPAs.

PRODUCTION POTENTIAL AREAS:

The climate is generally cool, and quite variable in precipitation throughout the RPU. The mean annual temperature range is 9^{o} to 15^{o}C. The greatest variation is in rainfall, which is from 250 mm per year on the drier lower slopes to as much as 1,000 mm per year at the higher elevations. Average annual temperature also varies with elevation. During the wet season (Nov. through Mar.) the average monthly rainfall ranges from less than 38 mm to as much as 125 mm.

The soils are Lithic Xerochrepts derived from limestone. They are shallow, stony, and severely eroded on the steeper slopes; bedrock outcrops are common. Slopes are very steep locally, in depressions and swales the soils are slightly deeper and more gently sloping. The RPU (a single PPA) is suited for use as woodland but rooting depth would be limited by shallowness of soil. Where soils are deeper and slopes more gentle, the PPA could be used more intensively, particularly for subsistence farming.

REPORTED OR OBSERVED CROPS AND VEGETATION:

The following crops were either reported or seen: fruit trees, (apples, apricots, cherries, plums), walnuts, pistachios, olives, poplars, eucalyptus, figs, grapes, grain, and cabbage.

A list of vegetation seen or reported is below:

Juniperus excelsa
Noaea mucronata
Berberis cretica
Onobrychis cornuta
Astragalus spp.
Acantholimon ulicinum
Polygonum spp.
Rhamnus libanotica
Phlomis brevilabris
Cirsium lappaceum
Cousinia hermonis
Poa diversifolia
Minuartia juniperina
Draba spp.
Marrubium libanoticum
Morina persica
Potentilla geranioides
Veronica macrostachya
Dactylis glomerata
Cytisus crotalarioides
Astragalus spinosa
Centaurea dumulosa
Jurinea stachelinae
Achillea sulphurea damascena
Acantholimon armenum
Stachys nivea
Agropyrum libanoticum
Cousinia dayi
Hedysarum coelesyriacum
Eryngium billardieri
Anthemis montana
Pyrethrum densum
Festuca valesiaca
Asphodeline damascena
Scabiosa argentea
Astragalus mollis
Pinus spp.
Parthenocissus sp.

Asphodeline taurica
Eryngium heldroidhii
Lotus corniculatus
Ziziphora celinopodioides
Melica nebrodensis
Senecio doriiformis
Celtis tournefortii
Fraxinus spp.
Loranthus europaeus
Lathyrus cassius
Pteris aquilina
Festuca laevis
Trifolium sp.
Medicago sp.
Vicia sp.
Lotus sp.
Scorpiurus sp.
Lathyrus sp.
Ononis sp.
Poa bulbosa
Hordeum bulbosum
Dactylis hispanica
Santolina sp.
Verbascum sp.
Melia azedarach
Salix sp.
Fraxinus sp.
Quercus aegilops
Sarcopoterium spinosum
Ceratonia siliqua
Nerium oleander
Stipa bromoides
Hyparrhenia hirta
Pollinia distachya
Urginea maritima
Gleditsia sp.
Platanus orientalis
Sophora sp.
Morus sp.
Robinia sp.
Euphorbia sp.
Anchusa sp.
Quercus infectoria
Quercus calliprinos
Avena pratensis
Cotoneaster pyracantha
Geranium libanoticum
Cupressus sempervirens
Styrax officinalis
Clematis flammula
Arbutus andrachne
Phillyrea media
Cistus villosus
Spartium junceum
Cytisus villosus
Ruscus aculeatus
Rhus cotinus
Lonicera etrusca
Pistacia palaestina
Erica verticillata
Asparagus aphyllus
Jasminum fruticans
Osyris alba
Ephedra campylopoda
Phlomis longifolia
Dryopteris australis
Origanum syriacus (marus)
Cedrus sp.
Smilax aspera
Orchidaceae
Cephalaria joppica
Althaea sp.

WATER RESOURCES AND USES:

A 1,718,000 m^3 capacity reservoir near Al-Zabadani is for domestic use and was filled in 1978. A 1,500,000 m^3 reservoir under construction near Damascus to the north is proposed for irrigation use. Twenty-eight springs are identified in this RPU with average flows totalling 9,499 l/sec, including Al-Figeh with 8,000 l/sec. These springs are located in the Barada and A'waj drainages primarily in the vicinity of Al-Zabadani. Eight test wells average 137 m deep with static level at 38 m, dynamic level at 46 m and flow of 23.6 m^3/hr. Nearly every well is in a different formation. The Water Basin Admnistration wells were 241 m deep but static and dynamic levls were similar to the above -- 36 m and 56 m, though yields were much smaller -- 6.1 m^3/hr.

The Barada Canal diversions reported in RPU 10 are mostly located in the eastern portion of RPU 15 but the water is all used downstream. RPU 15 is an important source of water for the Ghouta area. The Zabadani area is also an important water recreation area.

CROP RECOMMENDATIONS:

In RPU 15, shallow soils and steep slopes are the factors which limit any significant agricultural potential. In areas where irrigation might be feasible, low yields could be expected from small grains, fruit trees, tuber and bulb crops, vegetables, olives and grapes. Syrian scientists state that where soil conditions are appropriate, the zone is noted for its apples, cherries, raspberries, strawberries and potatoes.

PPA PROPERTIES	15-1
GENERAL	
elevation	1200-2600 m
dominant range of slope	more than 25%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	250-1,000 mm#
average temperature	9-15°C#
- Wet Season Characteristics	
average monthly precipitation	< 38 mm to 125 mm@
average monthly temperature	2-8°C+
period of wet season	November through March
SOILS	
principal components	Lithic Xerochrepts
depth to bedrock	less than 50 cm
texture	medium stony and bouldery
permeability	moderate
reaction	alkaline
salinity	-
available water capacity	low
drainage class	well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low
susceptibility to erosion	high
most intensive land use	woodland

RPU 16

GENERAL DESCRIPTION:

RPU 16 is a gently sloping valley in the Jebel esh Sharqi, northwest of Damascus. The valley is approximately 1200 m above sea level. The RPU encompasses approximately 7,100 hectares. The mean annual temperature range is 12° to 14°C. Annual precipitation ranges from 400 mm to 600 mm.

RPU 16 has been divided into two coarsely patterned PPAs on the basis of the climate.

PRODUCTION POTENTIAL AREAS:

PPA 16-1 is located principally in the northern end of the valley. The PPA has an average annual temperature of 12-14°C. Precipitation averages 500-600 mm yearly. During the wet season (Nov. through Mar.) the average monthly precipitation is greater than 90 mm.

PPA 16-2 comprises the remainder of the valley. It is dryer than PPA 16-1. Annual precipitation is 400-500 mm. During the wet season (Nov. through Mar.) the average monthly precipitation is about 85 mm.

The soils are Typic Chromoxererts, dark reddish clay soils that shrink and crack when dry and are sticky and plastic when wet. They are deep, moderately well drained, slowly permeable, and are well supplied with bases and plant nutrients. However, available moisture capacity is low. Inherently, these are productive soils and well suited for use as cropland. They would produce good yields of adapted crops if water were available and carefully managed.

REPORTED OR OBSERVED CROPS AND VEGETATION:

In this valley, fruit trees, such as cherries, peaches, plums and quince, are raised. Other tree crops include pistachio, olives, walnuts, poplars, and eucalyptus. Tomatoes, cabbage, and grapes are also found in the Zabadani plains. A list of the vegetation is below:

Astragalus spinosa
Noaea mucronata
Dactylis hispanica
Cousinia spp.
Carthamus spp.
Alkanna spp.
Onoperdon anisacanthum
Phalaris spp.
Echinops blanchaenus
Euphorbia spp.
Iris sp.
Robinia sp.
Polygala sp.
Digitaria sp.
Thymus syriacus
Hordeum bulbosum
Bromus danthoniae
Centaurea spp.
Anchusa spp.
Phlomis spp.
Salvia spp.
Silene coniflora
Hypericum triquetrifolium
Rhamnus sp.
Gleditsia sp.
Delphinium sp.
Setaria sp.
Rosa odorata

Althaea sp.
Fragaria sp.
Picea sp.
Platnus orientalis
Ligustrum sp.
Dianthus sp.
Clematis sp.
Pinus sp.
Catalpa sp.
Cedrus sp.

WATER RESOURCES AND USES:

This area is important as a water source as well as a recreation area. Although no reservoirs are located in the area, the Al Karu reservoir described in RPU 15 is near RPU 16 and the water may be used for domestic purposes. Nineteen springs are located in the area. Total flow averages 3,417 l/sec but 3,000 l/sec of this total is the large Barada Spring. No government test wells were included in the study.

CROP RECOMMENDATIONS:

RPU 16 is made up of two PPAs, both of which have high potential for growing of rosaceous fruit trees under irrigation and medium potential for other fruit trees, olives, grapes, and certain vegetables. Without irrigation, PPA 16-2 is rather dry and seasonally too cold to have more than medium potential for small grains. PPA 16-1 is significantly wetter and may be rated medium for small grains and frost-tolerant non-rosaceous fruit trees and olives without irrigation.

PPA PROPERTIES	16-1	16-2
GENERAL		
elevation	1200 m	1200 m
dominant range of slope	0-3%	0-3%
portion of RPU	50%	50%
CLIMATE		
- Annual Characteristics		
average precipitation	500-600 mm# (579 mm)	400-500 mm# (487 mm)
average temperature	12-14°C#	13-14#°C 13.9°C
- Wet Season Characteristics		
average monthly precipitation	> 90 mm@ (99 mm)	> 60 mm@ (85 mm)
average monthly temperature	2-5°C+	5-8°C+
period of wet season	November through March	November through March
SOILS		
principal components	Typic Chromoxererts	Typic Chromoxererts
depth to bedrock	more than 50 cm	more than 50 cm
texture	moderately fine to fine	moderately fine to fine
coarse fragments	stone free	stone free
permeability	slow	slow
reaction	alkaline	alkaline
salinity	-	-
available water capacity	low	low
drainage class	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate to high	moderate to high
susceptibility to erosion	low	low
most intensive land use	cropland	cropland

RPU 17

GENERAL DESCRIPTION:

RPU 17 is a level plain of flint-strewn desert soils situated generally east of Damascus adjoining the northern edge of the basalt plateau. This RPU, which has a hot Mediterranean climate, has an elevation of approximately 700 m and includes an area of approximately 194,400 hectares.

The RPU is generally uniform in composition and comprises a single PPA.

PRODUCTION POTENTIAL AREAS:

The soils are Typic Torriorthents ranging in texture from medium to coarse and generally stone free. Deflation by winds has removed the fine material from the surface layer, leaving flint fragments as a thin protective layer on the surface. The soils are deep, well drained, moderately to rapidly permeable and have moderate to low available moisture capacities. Some parts of the PPA are slightly saline; scattered extensive saline depressions are common.

The PPA would be suited for use as cropland if water for irrigation were available, but careful management would be needed to prevent a build-up of salinity. Without irrigation, the PPA is suited only for use as rangeland. Management as cropland should include practices to control wind erosion.

The mean annual temperature range is 15° to 17°C. Annual precipitation ranges from 50 mm to 150 mm. During the wet season (Oct. through May) monthly temperature averages 11 to 14°C and the monthly precipitation less than 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

No crops were reported for this RPU. The natural vegetation includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Salsola vermiculata
Trifolium sp.
Medicago sp.
Vicia sp.
Lotus sp.
Scorpiurus sp.
Lathyrus sp.
Ononis sp.
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Adonis dentata
Artemisia herba-alba
Haloxylon spp.
Poa sinaica
Carex stenophylla
Erodium pulverulentum
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus

Poa bulbosa
Hordeum bulbosum
Dactylis hispanica
Helianthemum sessiliflorum
Heliotropium persicum
Noaea mucronata
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althea rufescens
Onosma aleppica
Phlomis damascena
Cousinia aleppica
Trigonella sp.
Leontodon hispidulus
Scabiosa aucheri
Lactuca orientalis
Centaurea damascena
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshoni
Artemisia scoparia
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Astragalus duplostrigosus
Scleropoa dichotoma
Bromus danthoniae
Salvia spp.

WATER RESOURCES AND USES:

Though soils are good quality and suitable for irrigation, prospects for water are small at best and there is no evidence of irrigated crops. One reservoir constructed by the government, with a capacity of 1,750,000 m^3, is intended for domestic use. In 1978, no water was stored because of low precipitation. No springs are shown for this RPU. The scattered wells are for livestock and domestic uses. Some government test wells are in the RPU. Three such wells in the western portion showed: average depth 209 m, static water level 66 m, dynamic level 110 m, yield 11.0 m^3/hr. These wells are in limestone formations.

CROP RECOMMENDATIONS:

RPU 17, consisting of a single PPA, is unsuited for the rainfed production of conventional major crops. With irrigation, however, it has high potential for some nonrosaceous fruit trees, as well as some vegetables, and medium potential for small grains, cotton, tuber/root crops, olives, and pulses.

PPA PROPERTIES	17-1
GENERAL	
elevation	700 m
dominant range of slope	0-3%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	50-150 mm# (99 mm)
average temperature	15-17^{o}C# (16.7^{o}C)
- Wet Season Characteristics	
average monthly precipitation	< 38 mm@ (12 mm)
average monthly temperature	11-14^{o}C^{+}
period of wet season	October through May
SOILS	
principal components	Typic Torriorthents
depth to bedrock	more than 1 m
texture	medium to coarse
coarse fragments	stone free
permeability	moderate to rapid
reaction	alkaline
salinity	-
available water capacity	moderate to low
drainage class	well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	moderate to low
susceptibility to erosion	moderate (wind)
most intensive land use	cropland, irrigated

RPU 18

GENERAL DESCRIPTION:

RPU 18 is a nearly level plain extending in a general west-east direction between Homs and Palmyra. It has an elevation of approximately 500-1200 m and includes an area of approximately 568,400 hectares.

The RPU has a uniform climate but the soils differ. Three coarsely patterned PPAs are distinguished on the basis of soil characteristics.

PRODUCTION POTENTIAL AREAS:

PPA 18-1 comprises about 90 percent of RPU 18. The soils are Typic Torriorthents, medium and coarse textured and generally stone free. They are deep, well drained, moderately to rapidly permeable, and have moderate to low available moisture capacities. Some parts of the PPA are slightly saline.

The PPA would be suited for use as cropland if irrigation water were available; however, careful management would be needed to prevent build-up of salinity levels. Without the irrigation the PPA would be suited only for use as rangeland. Management as cropland should include practices to control wind erosion.

PPA 18-2 consists of outliers of Lithic Camborthids like those comprising 40 percent of RPU 13. These very shallow and steeply sloping soils have no potential for agricultural use except for the poor quality range afforded by native vegetation.

PPA 18-3 is a shallow depression just south of Palmyra. The soils, Aeric Halaquepts, are somewhat poorly drained, medium textured, and saline. They have very limited potential for agricultural use unless reclamation measures to reduce soil salinity are used.

All PPAs in this RPU are characterized by a climate that is dry and usually has moderate to high temperatures during the summer, and winters that are cool and moist. The mean annual temperature range is from 15° to 19°C. Annual precipitation ranges from 100 mm to 150 mm. During the wet season (Oct. through May) the average monthly precipitation is less than 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

The following crops were reported or seen in RPU 18, although not all were grown on a commercial scale: barley, corn, tomatoes, fruit trees, grapes, and lettuce.

Vegetation in this RPU includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala

Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Scabiosa aucheri
Tamarix sp.
Frankenia spp.
Halocnemum strobilaceum
Salicornia herbacea
Salsola crassa
Aelurepus littoralis
Juncus maritimus
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Halogeton alopecuroides
Stipa parviflora
Onobrychis ptolemaica
Anabasis aphylla
Statice palmyrensis
Sphenopus divaricatus

WATER RESOURCES AND USES:

Soils here are mostly suitable for irrigation but water prospects appear meagre. Possibly the greatest hope is for a few more wells for domestic and livestock uses. Small areas of rainfed crops are grown. Some irrigation occurs, especially around Palmyra. No streams exist in this area. One reservoir has 5,000,000 m^3 capacity for domestic use but zero storage in 1978. Available data and maps do not report springs in RPU 18 but obviously there is water from this source at Palmyra and possibly elsewhere.

Government test wells for study and domestic and livestock uses are scattered over the area. Eight such test wells show an average depth of 196 m, static level of 38 m, dynamic level of 55 m and average yield of 12.7 m^3/hr. Wells were in limestone formation in combination with marls, sand, or silex.

CROP RECOMMENDATIONS:

RPU 18 suffers from a uniformly dry climate, within which three different soil types offer varying potentials for irrigated agriculture: PPA 18-1 is similar to PPA 17-1, and, under irrigation, has high potential for some nonrosaceous fruit trees and some vegetables, and medium potential for small grains, cotton, tuber/root crops, olives, and pulses. PPA 18-2 and 18-3 have soils which are presently unsuited to agriculture and whose potential would be little enhanced by irrigation under any reasonable level of technology.

PPA PROPERTIES	18-1	18-2	18-3
GENERAL			
elevation	500-800 m	800-1200 m	500 m
dominant range of slope	0-3%	25-40%	0-3%
portion of RPU	90%	5%	5%
CLIMATE			
- Annual Characteristics			
average precipitation	100-150 mm# (119-127 mm)	100-150 mm# (119-127 mm)	100-150 mm# (119-127 mm)
average temperature	15-19^{o}C# (15.8-18.8^{o}C)	15-19^{o}C# (15.8-18.8^{o}C)	15-19^{o}C# (15.8-18.8^{o}C)
- Wet Season Characteristics			
average monthly precipitation	< 38 mm@ (15-16 mm)	< 38 mm@ (15-16 mm)	< 38 mm@ (15-16 mm)
average monthly temperature	11-15^{o}C^{+}	11-15^{o}C^{+}	14-15^{o}C^{+}
period of wet season	October through May	October through May	October through May
SOILS			
principal components	Typic Torriorthents	Lithic Camborthids	Aeric Halaquepts
depth to bedrock	greater than 1 m	less than 50 cm	greater than 1 m
texture	medium to coarse	medium	medium
coarse fragments	stone free	stone free	stone free
permeability	moderate to rapid	moderate	moderate
reaction	alkaline	alkaline	alkaline
salinity	slightly saline	-	saline
available water capacity	moderate to low	low	moderate
drainage class	well drained	well drained	somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate to low	low	low
susceptibility to erosion	moderate (wind)	high	low
most intensive land use	cropland (irrigated)	rangeland	pastureland

RPU 19

GENERAL DESCRIPTION:

RPU 19 is a broad area of rolling plains, steep hills and ridges, and shallow soils. It occurs in three areas mostly between Homs and Deir-ez-Zor. It covers an area of approximately 1,317,200 hectares. Elevations range from 600-1300 m in the west and 350-650 m in the east.

The RPU consists of two coarsely patterned PPAs differentiated on the basis of topography and depth of soil.

PRODUCTION POTENTIAL AREAS:

PPA 19-1 comprises undulating, rolling, hilly, and steep terrain, approximately 85 percent of the RPU. The soils are Lithic Camborthids, Lithic Calciorthids, and Lithic Torriorthents. All are shallow and stony, and outcrops of the bedrock, mostly limestone, are common and, in places, extensive. Because of shallowness and stoniness of the soils and very low precipitation, the PPA has little potential for agricultural use except as rangeland.

PPA 19-2 consists of extensive level plains irregularly distributed throughout the RPU, mostly in the segment nearest Homs. The soils are Typic Torriorthents like those in RPU 18, deep, medium and coarse textured soils that are moderately to rapidly permeable and have relatively low available moisture capacity. The PPA has potential for use as cropland if water for irrigation could be made available; without water, it is suited only for use as rangeland.

The climate of the RPU is characterized by an annual precipitation range of 100 mm to 250 mm. The mean annual temperature range is 15^{o} to 20^{o}C. The wet season (Oct. through May) has an average monthly precipitation of less than 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

No crops were reported for this RPU; however, some plants reported for this area are listed below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Halogeton alopecuroides
Scabiosa aucheri
Leontodon hispidulus
Stipa parviflora
Centaurea spp.
Agropyron libanoticum
Phlomis damascena
Arrhenatherum kotschyi
Cytisus crotalarioides
Salvia spinosa
Evax contracta
Malva aegyptiaca
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Peganum harmala

Astragalus tribuloides
Anthemis deserti-syriaci
Malcomia torulosa
Rhamnus palaestina
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Pistacia atlantica

WATER RESOURCES AND USES:

A few dryland crops are produced but the area is largely suited for range use. A relatively small area might produce fair irrigated crops if water were available. However, short of scattered small areas served by wells, there is no evidence of water currently available for irrigated crops. Five reservoirs were constructed in the RPU with total capacity of 3,723,000 m^3. Four reservoirs are strictly for domestic use but only one of them stored any water in 1978. A fifth reservoir constructed for irrigation and domestic use stored no water in 1978. Two additional reservoirs, capacity 13 million m^3, are planned for construction by the end of 1981.

No springs are shown by available data. A large number of government test wells are located in the RPU. These wells averaged 281 m in depth. Static water level was 110 m and dynamic level 136 m. Yield was 10.3 m^3/hr per well. Dominant formation was limestone in combination with marls or silex.

CROP RECOMMENDATIONS:

RPU 19 has a dry climate poorly suited for rainfed agriculture. PPA 19-1 has negligible potential for conventional major crops. With irrigation, PPA 19-2 may be rated high for some nonrosaceous fruit trees, as well as some vegetables, and medium for small grains, cotton, tuber/root crops, olives, and pulses.

PPA PROPERTIES	19-1	19-2
GENERAL		
elevation	350-1300 m	600-1000 m
dominant range of slope	8-45%	0-8%
portion of RPU	85%	15%
CLIMATE		
- Annual Characteristics		
average precipitation	100-250 mm# (142 mm)	100-250 mm# (142 mm)
average temperature	15-20^{o}C# (17.5^{o}C)	15-20^{o}C# (17.5^{o}C)
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@ (18 mm)	< 38 mm@ (18 mm)
average monthly temperature	10-14^{o}C^{+}	11-14^{o}C^{+}
period of wet season	October through May	October through May
SOILS		
principal components	Lithic Camborthids Lithic Calciorthids Lithic Torriorthents	Typic Torriorthents
depth to bedrock	less than 50 cm	greater than 50 cm
texture	medium	medium to coarse
coarse fragments	stony, bouldery	mostly stone free
permeability	moderate to rapid	moderate to rapid
reaction	alkaline	alkaline
salinity	-	slightly saline
available water capacity	low	medium to low
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	low	moderate to low
susceptibility to erosion	high	low
most intensive land use	rangeland	cropland, irrigated

RPU 20

GENERAL DESCRIPTION:

RPU 20 consists of level to rolling plains with shallow clay soils. It occurs in two broad areas, one oriented in a north-south direction east of Hama and the other extending northeast from the vicinity of Aleppo. Together the two areas cover 833,000 hectares. Elevation ranges from 350-600 m. The mean annual temperature range is 15° to 17°C. Annual precipitation ranges from 150 mm to 250 mm.

The RPU is divided into three coarsely patterned PPAs on the basis of soil depth and rainfall.

PRODUCTION POTENTIAL AREAS:

PPA 20-1 comprises soils shallow to the underlying bedrock or petrocalcic layer (a subsurface layer cemented by calcium carbonate). They are Lithic Xerorthents, vertic phase, and Lithic Xerochrepts. In addition to shallowness, these soils are also characterized by a high content of clay that is hard and cracked when dry, and sticky and plastic when wet. They are slowly permeable and have low available water capacity. The PPA has a low potential for agricultural use because of the low available moisture capacity, shallowness of soil over rock or rock like layers, and the difficulty of managing the heavy clays. It is best suited for use as pastureland or rangeland. If extraordinary expenditures are feasible, the petrocalcic layer can be broken down by use of heavy equipment thus increasing the effective depth of soil. If such treatment were used, the PPA could be used as cropland for production of adapted crops.

In PPA 20-1 (located in the drier eastern part of the RPU) the wet season (Nov. through May) has an average monthly precipitation of less than 38 mm.

PPA 20-2 is approximately 10 percent of the RPU. It includes the deeper soils in the unit, generally located in inextensive areas east of Aleppo and east and southeast of Homs. These soils are Typic Chromoxererts and Vertic Xerochrepts. They are deep clay soils similar to those in PPA 20-1 with low rates of permeability and low to moderate available moisture capacities. The PPA is suited for use as cropland but careful management of the clay soils and irrigation would be necessary to assure optimum yields. During the wet season (Nov. through May) the average monthly precipitation ranges from 25 to 39 mm.

PPA 20-3 is similar to PPA 20-2 with respect to the soils. During the wet season (Nov. through May) the average monthly precipitation is 43-56 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Wheat and barley are reported to be low yielding in RPU 20. Other crops include pistachio, grapes, almonds, lettuce, cotton, corn, fruit trees, olives, cabbage, figs, poplars, faba beans, onions, tomatoes, and pomegranates. Grapes were intercropped with fruit trees, as were faba beans with pomegranates.

A flora list for the RPU follows:

Astragalus spinosa
Thymus syriacus
Lactuca orientalis
Centaurea damascena

Noaea mucronata
Hordeum bulbosum
Dactylis hispanica
Bromus danthoniae
Cousinia spp.
Centaurea spp.
Carthamus spp.
Anchusa spp.
Alkanna spp.
Phlomis spp.
Onoperdon anisacanthum
Salvia spp.
Phalaris spp.
Silene coniflora
Echinops blanchaenus
Hypericum triquetrifolium
Euphorbia spp.
Canna sp.
Pinus sp.
Astragalus spp.
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althaea rufescens
Onosma aleppica
Phlomis damascena
Verbascum sp.
Cousinia aleppica
Trigonella sp.
Stipa spp.
Juniperus sp.
Morus sp.
Eryngium sp.

WATER RESOURCES AND USES:

The RPU occurs in at least five hydro subbasins. Three reservoirs (Kafat-Hama - 1.5 million m^3, Chahba-Aleppo - 6 million m^3 and Jallouda-Membig - 3.5 million m^3) are located in the RPU; the latter reservoir is in the Euphrates drainage. The Hama reservoir is labelled as irrigation-domestic. The purpose of the other two reservoirs is somewhat unclear; they are near cities so may be used for domestic purposes or flood control.

Only one spring - flowing 27 l/sec - near Aleppo is in the RPU. The western portion of the Meskeneh Unit of the Euphrates project lands is in this RPU. Thirteen government test wells in this study are in the Homs-Hama area and seven are in the Aleppo area. The Aleppo wells averaged 176 m in depth with a static level of 92 m and dynamic level of 97 m. Yield was 13.3 m^3/hr. Limestone formation predominated. The Homs-Hama wells were somewhat deeper -- 200 m, but water levels were much shallower -- 32 m and 42 m. Most of these latter wells were in gravel formation.

No major irrigation works are in the RPU. At the same time, large areas of irrigated crops are grown. Water for much of the irrigation is probably supplied by wells. The Queiq River traverses the western portion of the RPU around Aleppo; at this point it flows about 88 million m^3 per year but it appears that most of this water is used in Irrigation Network 8 downstream in RPU 26.

The city of Aleppo has a large requirement for domestic water and sewage disposal facilities. The latter facilities are entirely inadequate. Domestic water is now obtained from the Euphrates River and Lake Al-Assad; present supplies are reasonably adequate but if the population continues to increase, it has been estimated that demand will exceed supply in the relatively near future. A recently completed line from Lake Al-Assad supplies 220,000 m^3/day which is about 145 liters per capita per day for Aleppo or somewhat higher than average urban consumption at the present time.

A sugar factory, cement plant, and glass plant in Aleppo are among industries requiring substantial amounts of water. Fruit canning at Idleb also requires a

considerable quantity of water. A second cement plant is under construction at Aleppo. Sheep, goats, horses and cattle are raised in the Aleppo area and make some demands on the available water supply.

CROP RECOMMENDATIONS:

PPA 20-3 represents the productive heartland of RPU 20, and has medium potential for small grains, oil crops, fruit trees, olives and some pulses even without irrigation, and high potential for these with irrigation. PPAs 20-1 and 20-2 fall within a climate so dry that irrigation would normally be required for conventional major crops. However, PPA 20-1 is defined by soils unusable in their present state and of problematic use even if altered. PPA 20-2 may be rated high for irrigated cotton, olives, oil crops, some fruit trees (nonrosaceous), and medium for small grains and vegetables.

PPA PROPERTIES	20-1	20-2	20-3
GENERAL			
elevation	350-600 m	350-600 m	350-600 m
dominant range of slope	0-8%	0-3%	0-3%
portion of RPU	80%	10%	10%
CLIMATE			
- Annual Characteristics			
average precipitation	150-250 mm#	150-250 mm#	150-250 mm#
average temperature	15-17°C#	15-17°C# 16.3°C)	15-17°C#
- Wet Season Characteristics			
average monthly precipitation	< 60 mm@ (25-26 mm)	< 38 mm@ (25-39 mm)	< 60 mm@ (43-56 mm)
average monthly temperature	10-13°C+	11-12°C+	10-13°C+
period of wet season	November through May	November through May	November through May
SOILS			
principal components	Lithic Xerorthents, vertic phase Lithic Xerochrepts	Typic Chromoxererts Vertic Xerochrepts	Typic Chromoxererts Vertic Xerochrepts
depth to bedrock	less than 50 cm	greater than 50 cm	greater than 50 cm
texture	fine	fine	fine
coarse fragments	stone free	stone free	stone free
permeability	slow	slow	slow
reaction	alkaline	alkaline	alkaline
salinity	-	-	-
available water capacity	low	low	low
drainage class	well drained	well and moderately well drained	well and moderately well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	low	moderate to high	moderate to high
susceptibility to erosion	moderate	low	low
most intensive land use	rangeland	cropland (irrigated)	cropland

RPU 21

GENERAL DESCRIPTION:

RPU 21 is a nearly level plain with a few low limestone ridges located south of Homs. The elevation is 800-1200 m. RPU 21 covers an area of approximately 120,400 hectares.

The RPU is similar to RPU 18 to the east; the principal distinction is the slightly greater amount of precipitation in RPU 21. Two coarsely patterned PPAs comprising the RPU are distinguished on the basis of topography and soil depth.

PRODUCTION POTENTIAL AREAS:

PPA 21-1 consists of a nearly level plain. The soils are Xeric Torriorthents and Typic Torriorthents; they are deep, well drained, medium and coarse-textured soils that have moderate to rapid rates of permeability and moderate to low available moisture capacities. They are alkaline and some areas are slightly saline. The PPA would be suitable for use as cropland, but irrigation would be required for most crops. Without irrigation, the PPA would be suitable for use as rangeland.

PPA 21-2 includes the low, gently sloping limestone ridges. The soils are shallow, stony Lithic Camborthids in the east and Lithic Xerochrepts in the western part of the RPU. Agricultural potential is limited by shallowness of the soils and low rainfall. The PPA has little potential for development, and is best suited for use as rangeland.

For both PPAs, the mean annual temperature range is 13° to 16°C, the annual precipitation ranges from 150 mm to 200 mm, and during the wet season (Oct. to May) the average monthly precipitation is less than 38 mm.

The extreme northern part of RPU 21 receives more precipitation annually than regions farther south. A gap in the Anti-Lebanons is thought to produce this increase.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Wheat, barley, and apricots are reported for RPU 21. Additionally, fruit trees, tomatoes, cabbage (monocropped, and also intercropped with tomato), olives, figs, grapes, corn, irrigated grain, and irrigated radishes were seen.

Vegetation which has been reported or seen is listed below:

Lactuca orientalis
Centaurea damascena
Astragalus spp.
Noaea mucronata
Anchusa strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althaea rufescens
Onosma aleppica
Phlomis damascena
Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Ephedra alata
Carex stenophylla
Centaurea laxa
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata

Bromus danthoniae
Cousinia aleppica
Salvia spp.
Trigonella sp.
Stipa spp.
Anabasis aphylla
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Helianthemum aegyptiacum
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Scabiosa aucheri
Salicornia europaea
Hypecoum pendulum
Adonis dentata

WATER RESOURCES AND USES:

Soils in some of this area are suitable for crop production, but precipitation is too low for most crops and water for irrigation is not available. One reservoir (capacity 1,630,000 m^3) is in the RPU near Deir Atiya for irrigation and domestic use but stored no water in 1978. A 400,000 m^3 reservoir is under construction in the same vicinity. No springs are shown in the RPU. Two government test wells and three Water Basin Administration wells are in this RPU. The two test wells averaged 168 m in depth, with static water level 119 m and dynamic level 120 m. The yields were large -- 41.8 m^3/hr average. The WBA wells were deeper -- 492 m -- with static level 176 m; test information had not been reported. No aquifer information is available.

CROP RECOMMENDATIONS:

RPU 21 enjoys somewhat greater precipitation than RPU 18, but not enough to evade the irrigation requirements for most conventional major crops. PPA 21-1 has medium potential for irrigated small grains, olives, grapes and some vegetables, and for dry farming of winter small grains (barley would be riskier than wheat). PPA 21-2 has little potential for conventional major crop production.

PPA PROPERTIES	21-1	21-2
GENERAL		
elevation	800-900 m	900-1200 m
dominant range of slope	0-3%	3-15%
portion of RPU	90%	10%
CLIMATE		
- Annual Characteristics		
average precipitation	150-200 mm# (161-181 mm)	150-200 mm# (161-181 mm)
average temperature	13-16°C# (15.4°C)	13-16°C# (15.4°C)
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@ (20-25 mm)	< 38 mm@ (20-25 mm)
average monthly temperature	4-9°C+	4-8°C+
period of wet season	October to May	October to May
SOILS		
principal components	Xeric Torriorthents Typic Torriorthents	Lithic Camborthids Lithic Xerochrepts
depth to bedrock	greater than 50 cm	less than 50 cm
texture	medium and coarse	medium
coarse fragments	stone free	stony
permeability	moderate to rapid	moderate
reaction	alkaline	alkaline
salinity	-	-
available water capacity	moderate to low	moderate
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate to low	low
susceptibility to erosion	low	moderate
most intensive land use	cropland, irrigated	rangeland

RPU 22

GENERAL DESCRIPTION:

RPU 22 consists of the steeply sloping northern part of the Jebel esh Sharqi. It is an area of 44,300 hectares located south of Homs. Elevations range from 750 to 1750 m.

The RPU is generally uniform in composition and comprises a single PPA.

PRODUCTION POTENTIAL AREAS:

The soils, Lithic Xerochrepts, are steep, shallow, and stony. Outcrops of the limestone bedrock are common. In inextensive depressions and swales, they are slightly deeper and slopes are more gently sloping.

The PPA is suited for use as woodland. Rooting depth for trees or other vegetation is limited by shallowness of soil to the underlying bedrock. In local areas of deeper, more gently sloping soils, the PPA could be used more intensively for subsistence farming.

The mean annual temperature range is 12° to 17°C and annual precipitation ranges from 200 mm to 350 mm. The average monthly precipitation is less than 38 mm while the average monthly temperature is 4 to 10°C during the wet season (Nov. through Mar.).

REPORTED OR OBSERVED CROPS AND VEGETATION:

No crops were observed or reported for the RPU. A list of some of the vegetation is below:

Anabasis aphylla
Haloxylon articulatum
Peganum harmala
Hordeum bulbosum
Salvia sponosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Phalaris spp.
Echinops blanchaenus
Euphorbia spp.
Astragalus spinosa
Thymus syriacus
Noaea mucronata
Dactylis hispanica
Bromus danthoniae
Cousinia spp.
Centaurea spp.
Anchusa spp.
Alkanna spp.
Phlomis spp.
Onoperdon aniscanthum
Salvia spp.
Silene coniflora
Hypericum triquetrifolium

WATER RESOURCES AND USES:

No reservoirs or springs are shown for the area. One Water Basin Administration test well is in this study. It was 301 m deep with static and dynamic levels both at 66 m. The yield was only 5.2 m^3/hr. Potential water development appears to be nil.

The Upper Orontes River originating in Lebanon, constitutes the western boundary of this RPU. No irrigation is reported.

CROP RECOMMENDATIONS:

RPU 22 is generally not suited for agriculture using conventional major crops.

PPA PROPERTIES	22-1
GENERAL	
elevation	750-1750 m
dominant range of slope	25-45%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	200-350 mm#
average temperature	12-17°C#
- Wet Season Characteristics	
average monthly precipitation	< 38 mm@
average monthly temperature	4-10°C+
period of wet season	November through March
SOILS	
principal components	Lithic Xerochrepts
depth to bedrock	less than 50 cm
texture	medium
coarse fragments	stony and bouldery
permeability	moderate
reaction	alkaline
salinity	-
available water capacity	low
drainage class	well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low
susceptibility to erosion	high
most intensive land use	woodland

RPU 23

GENERAL DESCRIPTION:

RPU 23 is a nearly level plain located east and southeast of Homs. It has an extent of approximately 38,400 hectares. Elevation is approximately 550-600 m. The mean annual temperature range is 16° to 17°C. Annual precipitation ranges from 150 mm to 400 mm.

RPU 23 has been divided into two coarsely patterned PPAs on the basis of climate.

PRODUCTION POTENTIAL AREAS:

PPA 23-1 comprises the northern part of the RPU, above the 34° N parallel. The climate is characterized by an average annual precipitation of 300-400 mm, and the average monthly precipitation during the wet season (Nov. through Mar.) is greater than 60 mm.

PPA 23-2 is the southern and drier part of RPU 23. The average annual precipitation is less than 300 mm. During the wet season (Nov. through Mar.) the average monthly precipitation generally ranges from 38-48 mm. This PPA, which borders RPU 26, is a transition to an area of higher rainfall, possibly caused by the influence of Bahr at Homs, and of the Lebanon and el-Ansariye Mountains.

The soils of these PPAs are Xeric Torriorthents, stony soils of various depths over the underlying limestone conglomerate. They are well drained, medium textured, and moderately to rapidly permeable; they are well supplied with bases and the soils are alkaline. Available moisture is limited not only by the climate but also by the relatively shallow depth of soil over the coarse stony substratum.

The soils are potentially moderately productive and would be suited for use as cropland, particularly for less intensively cultivated crops, where stoniness is not severe and water for irrigation could be made available.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops reported, or seen, are wheat, barley, lettuce, cotton, and fruit trees.

Vegetation includes:

Astragalus spinosa
Thymus syriacus
Noaea mucronata
Hordeum bulbosum
Dactylis hispanica
Bromus danthoniae
Sarcopoterium spinosum
Cousinia spp.
Centaurea spp.
Carthamus spp.
Anchusa spp.
Alkanna spp.
Phlomis spp.
Onoperdon anisacanthum
Lactuca orientalis
Centaurea damascena
Astragalus spp.
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althaea rufescens
Onosma aleppica
Phlomis damascena
Reseda lutea

Salvia spp.	Cousinia aleppica
Phalaris spp.	Trigonella sp.
Silene coniflora	Stipa spp.
Echinops blanchaenus	Scabiosa sp.
Hypericum triquetrifolium	Euphorbia spp.

WATER RESOURCES AND USES:

Soils in this RPU are reasonably productive which, in combination with moderate precipitation, permits rainfed agriculture. They are also suitable for irrigated agriculture but little water is available, though small areas of irrigated crops probably are served by well water. One reservoir, Meskeneh, capacity 1.0 million m^3, is near Homs. Available data does not show its specific use. It filled 100 percent in 1978. No springs are shown in the RPU.

Three government test and Water Basin Administration wells are in this study. Two test wells were 222 m deep with static level of one well at 36 m and dynamic level at 75 m. The yield of this well was 15.4 m^3/hr. The WBA well was especially deep -- 555 m --with static level at 25 m and dynamic level at 64 m. The yield was very low -- 0.3 m^3/hr.

CROP RECOMMENDATIONS:

Under irrigated conditions, the two PPAs of RPU 23 are similar in cropping potential - high for small grains, cotton, vegetables, tuber/bulb crops, fruit trees, olives and pulses, medium for grapes. Under nonirrigated conditions, there would be no potential for cultivated crops in PPA 23-2, while in PPA 23-1, under the same conditions, medium potential for small grains, tuber/bulb crops, grapes, cotton, and selected vegetables could be expected.

PPA PROPERTIES	23-1	23-2
GENERAL		
elevation	550-600 m	550-600 m
dominant range of slope	0-3%	0-3%
portion of RPU	60%	40%
CLIMATE		
- Annual Characteristics		
average precipitation	300-400 mm#	150-300 mm# (222-273 mm)
average temperature	16-17°C#	16-17°C#
- Wet Season Characteristics		
average monthly precipitation	> 60 mm@	> 38 mm@ (38-48 mm)
average monthly temperature	8-10°C+	8-10°C+
period of wet season	November through March	November through March
SOILS		
principal components	Xeric Torriorthents	Xeric Torriorthents
depth to bedrock	more than 50 cm	more than 50 cm
texture	medium	medium
coarse fragments	stony	stony
permeability	moderate	moderate
reaction	alkaline	alkaline
salinity	-	-
available water capacity	moderate	moderate
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate	moderate
susceptibility to erosion	low	low
most intensive land use	cropland, irrigated	cropland, irrigated

RPU 24

GENERAL DESCRIPTION:

RPU 24 consists of two areas of level and undulating plains located generally northeast and southwest of Homs. Underlying materials consist of stony conglomerate. The RPU covers an area of approximately 90,900 hectares at an elevation of approximately 500 m. The mean annual temperature range is 16° to 17°C. Annual precipitation ranges from 250 mm to 600 mm.

Six PPAs comprise the RPU on the basis of topography, soil drainage class, and climate.

PRODUCTION POTENTIAL AREAS:

The climate of PPAs 24-1, 24-2, and 24-3 is characterized by an annual precipitation of 250-500 mm. During the wet season (Nov. through May) the average monthly precipitation is less than 38 mm.

PPA 24-1 comprises about 40 percent of the RPU. It is a level to gently sloping area southeast of Bahr at Homs and in an area northeast of Homs, and is dominated by Vertic Xerochrepts; these are well drained, fine textured, level to gently sloping reddish soils generally well supplied with nutrients and bases. Available moisture capacity is moderate, rate of permeability is low to moderate. Depth to the underlying limestone conglomerate is more than a meter. The soils are moderately to highly productive and the PPA is suited for use as cropland; water for irrigation would be a prerequisite for optimum yields of most crops. Coarsely intermingled with these soils are numerous small areas of soils that are shallow to the underlying limestone. They are difficult to distinguish by their surface configuration. Being shallow and stony, they have little potential for use as cropland but could be used as pastureland.

PPA 24-2 consists of an inextensive, level, wet plain southwest of Homs. The soils are Aeric Haplaquepts, somewhat poorly drained medium to fine textured soils of low permeability. Some of the area is slightly saline. The PPA has potential for use as cropland but intensive management would be needed to control moisture and prevent excessive accumulation of salts.

PPA 24-3 is an alluvial plain along the Orontes River. The soils are Typic Xerofluvents, deep, medium-textured and well-drained. Associated with them are areas of Aquic Xerofluvents, similar to the Typic Xerofluvents but moderately well to somewhat poorly drained. Both soils are alkaline and slightly to moderately saline. The PPA is suited for use as cropland but intensive management to control moisture and prevent excessive accumulation of salts would be needed.

PPAs 24-4, 24-5, and 24-6 are generally located in the northern parts of both sections of RPU 24. PPAs 24-4 and 24-5 may be found in the same bounds as PPA 24-1 and 24-2, respectively. Average precipitation ranges from 300-600 mm annually. During the wet season (Dec. through April) the average monthly precipitation averages about 83 mm.

The soils for PPAs 24-4, 24-5, and 24-6, respectively correspond to those for PPAs 24-1, 24-2, and 24-3. The soil descriptions may be found under those PPAs.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Reported crops for this RPU are wheat, almonds, grapes and some trees. Figs, corn, and fruit trees also were seen.

Reported or observed plants:

Astragalus spinosa
Noaea mucronata
Dactylis hispanica
Cousinia spp.
Carthamus spp.
Alkanna spp.
Onoperdon anisacanthum
Phalaris spp.
Echinops blanchaenus
Euphorbia spp.
Canna sp.
Anagallis sp.
Thymus syriacus
Hordeum bulbosum
Bromus danthoniae
Centaurea spp.
Anchusa spp.
Phlomis spp.
Salvia spp.
Silene coniflora
Hypericum triquetrifolium
Morus sp.
Papaver sp.

WATER RESOURCES AND USES:

Four springs in the Upper Orontes drainage are included in this RPU. Annual flows total 2,255 l/sec. A large portion of the RPU is above existing water facilities. One Orontes gauging station used in the study is in the RPU above the Qattineh reservoir. The average annual flow here for the data period was 536.1 million m^3. This water flows out and through the Qattineh reservoir, which has a capacity of 200 million m^3.

Irrigation network 10, to the east and south of Homs, is in this RPU. This is a proposed irrigation development but is currently in the inactive status. Three government test wells are in this study sample. Two test wells had depths, static level, and dynamic levels of 96 m, 30 m, and 36 m, respectively. Yields averaged 10.5 m^3/hr. The formation was limestone. The three levels for the Water Basin Administration wells were 200 m, 43 m, and 48 m; yield was 3.0 m^3/hr.

This RPU includes Al-Koseir Mantika which reports 8,965 hectares of irrigated crops and part of Al-Rastan Mantika but available maps do not permit conclusions about the location of irrigation. The (inactive) Upper Orontes Network of 15,000 hectares is in the southwest area of the RPU.

CROP RECOMMENDATIONS:

The crop adaptability situation in RPU 24 is complex, but if only conventional major crops are considered, things are somewhat simplified.

First, if irrigation is provided, the climatic differences between pairs of PPAs grouped according to soil (i.e., 24-1 and 24-4; 24-2 and 24-5; 24-3 and 24-6) are rendered insignificant. PPAs 24-1 and 24-4 would then be rated as having high potential for cotton, grapes, fruit trees, and oil crops, and medium potential for small grains, olives, pulses, and vegetables. PPAs 24-2 and 24-5 would be rated medium for cotton, oil crops, some vegetables, pulses and small grains. PPAs 24-3 and 24-6 would be rated high for the production of cotton, grapes, oil crops, vegetables, tuber/bulb crops, and small grains and medium for pulses and fruit trees.

Without irrigation, PPAs 24-1, 24-2, 24-3, and 24-5 are all unsuited to the production of these conventional major crops.

Finally, without irrigation, PPA 24-4 could be rated medium for the production of small grains, and some pulses; and PPA 24-6 medium for small grains.

PPA PROPERTIES	24-1	24-2	24-3
GENERAL			
elevation	500 m	500 m	500 m
dominant range of slope	0-8%	0-3%	0-3%
portion of RPU	40%	8%	5%
CLIMATE			
- Annual Characteristics			
average precipitation	250-500 mm#	250-500 mm#	250-500 mm#
average temperature	16-17°C#	16-17°C#	16-17°C#
- Wet Season Characteristics			
average monthly precipitation	< 38 mm@	< 38 mm@	< 38 mm@
average monthly temperature	7-10°C+	7-10°C+	7-10°C+
period of wet season	November through May	November through May	November through May
SOILS			
principal components	Vertic Xerochrepts	Aeric Haplaquepts	Typic Xerofluvents Aquic Xerofluvents
depth to bedrock	greater than 1 m	greater than 1 m	greater than 1 m
texture	fine	medium to fine	fine
coarse fragments	nonstony	nonstony	nonstony
permeability	moderate to low	low	moderately slow
reaction	alkaline	alkaline	alkaline
salinity	-	slightly saline	slightly saline
available water capacity	moderate	moderate	moderate
drainage class	well drained	somewhat poorly drained	moderately well to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate to high	moderate to low	moderate to high
susceptibility to erosion	low	low	none
most intensive land use	irrigated cropland	cropland (drained and irrigated)	irrigated cropland

PPA PROPERTIES	24-4	24-5	24-6
GENERAL			
elevation	500 m	500 m	500 m
dominant range of slope	0-8%	0-3%	0-3%
portion of RPU	35%	7%	5%
CLIMATE			
- Annual Characteristics			
average precipitation	300-600 mm# (403 mm)	300-600 mm# (403 mm)	300-600 mm# (403 mm)
average temperature	16-17^{o}C# (16.6^{o}C)	16-17^{o}C# (16.6^{o}C)	16-17^{o}C# (16.6^{o}C)
- Wet Season Characteristics			
average monthly precipitation	> 38 mm@ (83 mm)	> 38 mm@ (83 mm)	> 38 mm@ (83 mm)
average monthly temperature	7-10^{o}C^{+}	7-10^{o}C^{+}	7-10^{o}C^{+}
period of wet season	December through April	December through April	December through April
SOILS			
principal components	Vertic Xerochrepts	Aeric Haplaquepts	Typic Xerofluvents Aquic Xerofluvents
depth to bedrock	greater than 1 m	greater than 1 m	greater than 1 m
texture	fine	medium to fine	fine
coarse fragments	nonstony	nonstony	nonstony
permeability	moderate to low	low	moderately slow
reaction	alkaline	alkaline	slightly alkaline
salinity	-	slightly saline	slightly saline
available water capacity	moderate	moderate	moderate
drainage class	well drained	somewhat poorly drained	moderately well to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate to high	moderate to low	moderate to high
susceptibility to erosion	low	low	none
most intensive land use	cropland	cropland (drained and irrigated)	cropland

RPU 25

GENERAL DESCRIPTION:

RPU 25 is an extensive RPU (approximately 202,000 hectares) situated in four areas distributed from west of Homs northward almost to Idleb. It is mainly a limestone plain, although some inextensive areas underlain by basalt are included west of Hama. Elevation ranges from 250-500 m.

PPA 25 is divided into two PPAs based on soil characteristics.

PRODUCTION POTENTIAL AREAS:

PPA 25-1 consists of several discrete areas, all south of Idleb. The soils are Lithic Xerorthents; Lithic Xerorthents, vertic phase; and Lithic Xerochrepts. All are undulating to rolling, shallow, fine textured, stony soils over limestone or basalt. They are alkaline and have high base saturation. Available moisture capacity is low and permeability is slow. The PPA is poorly suited for use as cropland although it would be suitable for less intensive use, such as pasture and rangeland.

PPAs 25-2 comprises the deeper soils of the RPU. They occur mainly in the vicinity of Idleb and toward the northern border; they also occur inextensively in the gap in the mountains west of Homs. Soils in this PPA are like those in RPU #16 - Typic Chromoxererts. These are deep, well drained, fine textured soils. They become very hard and crack when dry and are sticky and plastic when wet. Available moisture capacity is low. Inherently, these are productive soils suited for use as cropland. They would produce good yields of adapted crops but would be difficult to manage. Irrigation would be required for optimum yields.

The climate for both PPAs is of little consequence with respect to crop production inasmuch as the soils are of poor quality. Precipitation ranges from 250 mm to 1,200 mm and the average annual temperature ranges from 16-19°C throughout the RPU. During the wet season (Nov. through April) the monthly precipitation averages from less than 38 mm to as much as 180 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops which have been reported or seen include vegetables, olives, wheat, cherries, cotton irrigated from wells, cabbage, sunflowers, grapes, figs, loquats, lentils, and pomegranates.

The flora includes:

Lactuca orientalis
Centaurea damascena
Astragalus spp.
Noaea mucronata
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Astragalus spinosa
Thymus syriacus
Hordeum bulvosum
Dactylis hispanica
Bromus danthoniae
Cousinia spp.
Centaurea spp.
Carthamus spp.
Anchusa spp.
Alkanna spp.
Phlomis spp.

Althaea rufescens
Onosma aleppica
Phlomis damascena
Orchidaxeae
Cousinia aleppica
Salvia spp.
Trigonella sp.
Cupressus sempervirens
Styrax officinalis
Laurus nobilis
Arbutus andrachne
Phillyrea media
Cistus villosus
Ruscus aculeatus
Cotinus coggygria
Lonicera etrusca
Pistacia palaestina
Erica verticillata
Asparagus aphyllus
Jasminum fruticans
Osyris alba
Ephedra campylopoda
Dryopteris australis
Stipa bromoides
Onoperdon anisacanthum
Phalaris spp.
Silene coniflora
Echinops blanchaenus
Hypericum triquetrifolium
Euphorbia spp.
Stipa spp.
Quercus aegilops
Quercus calliprinos
Quercus infectoria
Sarcopoterium spinosum
Ceratonia siliqua
Nerium oleander
Myrtus communis
Hyparrhenia hirta
Pollinia distachya
Urginea maritima
Cephalaria joppica
Clematis flammula
Lupinus sp.
Ricinus communis
Phlomis longifolia
Origanum syriacus (marus)
Smilax aspera

WATER RESOURCES AND USES:

Both rainfed winter and irrigated summer crops are grown. The soils are generally suitable for irrigated crop production. Surface water and wells are used for irrigation. Twelve reservoirs have been identified within this RPU. One small irrigation reservoir (230,000 m^3) is in the section near the Akkar Plain. Two reservoirs in the northern section have capacities of 230,000 m^3 and 478,000 m^3. The other nine reservoirs are in the area immediately west of Homs. Total capacity of these nine reservoirs is 223,694,000 m^3, of which 200,000,000 m^3 is in the Qattineh reservoir. All nine reservoirs are used for irrigation, probably in large part between Homs and Hama.

Only three small springs are located in this RPU. A gauging station on the coastal stream Janoubi is in this RPU. Average annual flow is 182 million m^3. Eighteen government test wells are in the study sample. These wells are located in the three areas in the Orontes and Aleppo Basins. Four test wells in the Aleppo Basin showed measurements of 288 m deep, 173 m static level, 216 m dynamic level and 14.0 m^3/hr yield. Five test wells in Homs-Hama area measured 232 m, 94 m, 108 m, and 19.1 m^3/hr, respectively. The latter wells were in basalt/limestone formation. Three Water Basin Administration wells in Aleppo Basin measured 276 m, 24 m, 39 m, and 10.6 m^3/hr. The WBA Homs-Hama wells showed 241 m, 21 m, 27 m, and 19.8 m^3/hr.

CROP RECOMMENDATIONS:

RPU 25 presents a complex picture with regard to crop adaptability, because it lies in an area where conditions change drastically over short distances. It has seemed best, however, to assemble this considerable heterogeneity into two PPAs, rather than to risk proliferation of miniscule agronomic units, each of little import, for national agricultural planning.

PPA 25-1 is of neglible potential for the production of conventional major crops, due to poor soil conditions.

PPA 25-2 forms a group of climate types in which the annual precipitation does not exceed 1,200 mm over the same type of soils. Areas within PPA 25-2 may be rated high potential for irrigated cotton, tuber/root crops, vegetables, olives, oil crops, small grains and rosaceous fruit trees. The potentials without irrigation would remain the same as under irrigation for the same crops, except small grains' potential would range from medium to high.

PPA PROPERTIES	25-1	25-2
GENERAL		
elevation	250-500 m	300-500 m
dominant range of slope	3-15%	0-8%
portion of RPU	50%	50%
CLIMATE		
- Annual Characteristics		
average precipitation	250-1,200 mm#	250-1,200 mm#
average temperature	16-19^{o}C#	16-19^{o}C#
- Wet Season Characteristics		
average monthly precipitation	<38 mm to 180 mm@	< 38 mm to 180 mm@
average monthly temperature	6-10^{o}C^{+}	6-10^{o}C^{+}
period of wet season	November through April	November through April
SOILS		
principal components	Lithic Xerorthents, vertic phase Lithic Xerorthents Lithic Xerochrepts	Typic Chromoxererts
depth to bedrock	less than 50 cm	1.5-2.0 m
texture	fine	fine
coarse fragments	stony	stony
permeability	slow	slow
reaction	alkaline	alkaline
salinity	-	-
available water capacity	low	low
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	low	moderate to high
susceptibility to erosion	moderate	low
most intensive land use	pastureland	irrigated and non-irrigated cropland

RPU 26

GENERAL DESCRIPTION:

RPU 26 consists of level, limestone plains. It occurs in three segments, one extending from Homs northward beyond Hama, another extending east from Idleb, and the third situated along the border, north of Aleppo. It covers an area of approximately 383,500 hectares. Elevation ranges from about 275 m to 500 m. The mean annual temperature is 16° to $18^{\circ}C$. Annual precipitation ranges from 300 mm to 600 mm.

The RPU has been divided into two coarsely patterned PPAs because of climatic differences. The soils of both PPAs are similar.

PRODUCTION POTENTIAL AREAS:

PPA 26-1 is in the northeastern part of the region north of Aleppo and in the eastern part of the region that includes Homs and Hama. During the single wet season (Nov. through April) monthly precipitation averages less than 60 mm.

PPA 26-2 is located in the western part of the region containing Homs and Hama and the region east of Idleb. During the wet season (Nov. through April) average monthly precipitation is greater than 60 mm.

The soils of both PPAs are Typic Chromoxererts. They are deep reddish brown, fine textured soils; stoniness is common. The soils are well drained but slowly permeable. They are alkaline and generally well supplied with plant nutrients. The RPU (PPA) is suited for use as cropland where stoniness is not a deterrent. Management for agriculture would be difficult because the clays are hard and cracked when dry and are quite sticky and plastic when wet. Supplemental irrigation would be needed to assure optimum yields.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops that were reported or seen were cabbage, grain, stunted corn, cotton, grapes, sugar beets, pistachio, olives, fruit trees, and figs.

List of the vegetation :

Cupressus sempervirens
Quercus aegilops
Thymus syriacus
Laurus nobilis
Quercus infectoria
Hordeum bulbosum
Phillyrea media
Ceratonia siliqua
Bromus danthoniae
Spartium junceum
Myrtus communis
Centaurea spp.
Ruscus aculeatus
Pollinia distachya
Anchusa spp.
Astragalus spinosus
Styrax officinalis
Quercus calliprinos
Noaea mucronata
Arbutus andrachne
Poterium spinosum
Dactylis hispanica
Cistus villosus
Nerium oleander
Cousinia spp.
Cytisus villosus
Hyparrhenia hirta
Carthamus spp.
Cotinus coggygria
Urginea maritima

Lonicera etrusca
Cephalaria joppica
Phlomis spp.
Erica verticillata
Asparagus aphyllus
Jasminum fruticans
Osytris alba
Ephedra campylopoda
Phlomis longifolia
Dryopteris australis
Origanum syriacus (marus)
Smilex aspera
Alkanna spp.
Pistacia palaestina
Clematis flammula
Onoperdon anisacanthum
Salvia spp.
Phalaris spp.
Silene coniflora
Echinops blanchaenus
Hypericum triquetrifolium
Euphorbia spp.
Stipa bromoides
Orchidaceae

WATER RESOURCES AND USES:

Six reservoirs, all located in the Homs-Hama section, have a total capacity of 278,550,000 m^3. Al-Rastan (225 million m^3) and Mahardah (50 million m^3) are the major storages. All reservoirs are used for irrigation and the two large reservoirs are also used for power generation and stream quality control. All were essentially filled to capacity in 1978. Another large dam - Kremish, with a capacity of 275 million m^3 - is proposed for construction on the Orontes between Homs and Hama; it would essentially complete harnessing of the Orontes River and would add 28-30,000 hectares of irrigated land in the Ghab Valley. A small dam is also prosposed on the Saroute River, which enters the Orontes below Hama.

Two gauging stations in this RPU were studied; one on the Orontes above Hama showed an average annual flow of 571 million m^3; the other, below Mahardah Dam, showed 236 million m^3 after diversions for Ghab Valley irrigation. Three government irrigation networks are in this RPU. The small Houle - 1,500 hectares - is below Teldow Dam. The second network of 20,000 hectares is the irrigated area generally between Homs and Hama. The third network is Matkh No. 8 with 14,860 hectares irrigated from the Kweik River.

One large spring - Chizer - is situated below Mahardah and has an average annual flow of 6,424 l/sec or 202 million m^3. Much of this water probably escapes to the sea. Three small springs - 64 l/sec total - are in the area near Idleb.

There are 46 test wells scattered over the three sections of the RPU. Eighteen test wells in Aleppo Basin averaged 229 m in depth, 88 m static level, 125 m dynamic level, and 18.0 m^3/hr. These wells are largely in limestone formation. The 18 test wells in Homs-Hama area averaged 196 m, 85 m, 106 m, and 21.2 m^3/hr; they are also in limestone formation. Ten Water Basin Administration wells in Homs-Hama averaged 242 m, 54 m, 77 m, and 5.6 m^3/hr, respectively.

In addition to water used for irrigation, considerable amounts of water are required for textile, tire manufacturing, cement and ceramic plants.

CROP RECOMMENDATIONS:

Under irrigation PPAs 26-1 and 26-2 have high potential for small grains, olives, pulses, vegetables, and nonrosaceous fruit trees, and medium potential for cotton, grapes, rosaceous fruit trees, and tuber/bulb crops. Under nonirrigated conditions PPA 26-2 could be expected to have medium potential for small grains, grapes, olives, and pulses, but in PPA 26-1 only small grains, olives, and some pulses would be likely to be as productive.

PPA PROPERTIES	26-1	26-2
GENERAL		
elevation	275-500 m	275-500 m
dominant range of slope	0-3%	0-3%
portion of RPU	30%	70%
CLIMATE		
- Annual Characteristics		
average precipitation	300-500 mm# (325-378 mm)	300-500 mm# (369-477 mm)
average temperature	16-18°C#	18°C
- Wet Season Characteristics		
average monthly precipitation	< 60 mm@ (45-56 mm)	> 60 mm@ (60-74 mm)
average monthly temperature	7-9°C+	7-9°C+
period of wet season	November through April	November through April
SOILS		
principal components	Typic Chromoxererts	Typic Chromoxererts
depth to bedrock	more than 1.5 m	more than 1.5 m
texture	fine	fine
coarse fragments	stony	stony
permeability	slow	slow
reaction	alkaline	alkaline
salinity	-	-
available water capacity	low to moderate	low to moderate
drainage class	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate	moderate
susceptibility to erosion	low	low
most intensive land use	cropland	cropland

RPU 27

GENERAL DESCRIPTION:

RPU 27 is a gently sloping basalt plain with shallow, stony soils located south of Jebel al-Ansariye and west of Homs. It is relatively inextensive, covering an area of approximately 25,400 hectares. Elevation is 400-500 m. The mean annual temperature range is 16° to 18°C. Annual precipitation ranges from 500 mm to 1,000 mm.

RPU 27 is divided into four coarsely patterned PPAs on the basis of depth of soils and precipitation.

PRODUCTION POTENTIAL AREAS:

In PPA 27-1, the soils are Lithic Xerorthents, vertic phase. These are dark reddish, fine textured soils that are shallow to the underlying basalt. Stoniness is common. They are slowly permeable and have low available moisture capacity. Because of shallowness and stoniness, the PPA is best suited for use as pastureland. Because the agricultural potential is very low, this PPA has not been subdivided although three crop climate areas occur within it.

The annual precipitation ranges from 500-1000 mm. During the wet season (Nov. through April) the average monthly precipitation ranges from less than 60 mm to greater than 90 mm east of Arida.

In PPA 27-2, the soils are deeper than in PPA 27-1. They are Typic Chromoxererts. These are distributed in depressions and more gently sloping areas, and are most extensive in the southeast part of the RPU. Properties are generally like those of the soils in PPA 27-1 except that these are deeper. The PPA is suited for use as cropland but the clay soils require careful management and irrigation would be necessary for optimum yields. Annual precipitation ranges from 500-1,000 mm. During the wet season (Nov. through April) the average monthly precipitation that is less than 60 mm.

PPA 27-3 is located primarily in the eastern part of the RPU. The soils are like those in PPA 27-2. Precipitation ranges from 600-1,000 mm annually. During the wet season (Nov. through April) the precipitation averages more than 60 mm.

PPA 27-4 is generally located in the central part of RPU 27. The soils are also like those in PPA 27-2. The annual precipitation average is 800-1,000 mm. During the wet season (Nov. through April) the average monthly precipitation exceeds 90 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Irrigated cotton, sugar beets, fruit trees, corn, and wheat have been reported or seen in the RPU.

The flora in this RPU includes the following plants:

Astragalus spinosa
Noaea mucronata
Dactylis hspanica
Cousinia spp.
Carthamus spp.
Alkanna spp.

Thymus syriacus
Hordeum bulbosum
Bromus danthoniae
Centaurea spp.
Anchusa spp.
Phlomis spp.

Onoperdon anisacanthum
Phalaris spp.
Echinops blanchaenus
Euphorbia spp.
Salvia spp.
Silene coniflora
Hypericum triquetrifolium

WATER RESOURCES AND USES:

Most of the area is suited only for pasture land, but about a third is suitable for irrigated crops as well as rainfed crops. No reservoirs or government test wells are in the area. One fairly large spring - annual flow of 850 l/sec - is in the RPU. There appears to be a small area of intensive cropland and possibly some irrigated crops.

CROP RECOMMENDATIONS:

PPA 27-1 is generally unsuited for production of conventional major crops with or without irrigation. PPAs 27-2 and 27-3 share the same soil but differ in the intensity of the wet season. Yields may be expected to differ somewhat, but the general suitability for most crops is adjudged similar for the two: with irrigation, the PPAs have medium potential for small grains, cotton, nonrosaceous fruit trees, pulses, olive, grape, and oil crops. Small grains have low yield potential under rainfed production in these two PPAs. PPA 27-4 has the same kind of soil as the two preceding PPAs, but has a wetter climate. With irrigation, the potential for production of major crops is the same as for PPAs 27-2 and 27-3 above. Without irrigation, PPA 27-4 has medium potential not only for small grains, but also for cotton, some vegetables, and pulses.

PPA PROPERTIES	27-1	27-2	27-3	27-4
GENERAL				
elevation	400-500 m	400-500 m	400-500 m	400-500 m
dominant range of slope	3-8%	0-3%	0-3%	0-3%
portion of RPU	80%	7%	7%	6%
CLIMATE				
- Annual Characteristics				
average precipitation	500-1,000 mm#	500-1,000 mm#	600-1,000 mm#	800-1000 mm#
average temperature	16-18^{o}C#	16-18^{o}C#	16-18^{o}C#	16-18^{o}C#
- Wet Season Characteristics				
average monthly precipitation	< 60 to >90 mm@	< 60 mm@	> 60 mm@	> 90 mm@
average monthly temperature	11-12^{o}C^{+}	11-12^{o}C^{+}	11-12^{o}C^{+}	11-12^{o}C^{+}
period of wet season	November through April	November through April	November through April	November through April
SOILS				
principal components	Lithic Xerorthents, vertic phase	Typic Chromoxererts	Typic Chromoxererts	Typic Chromoxererts
depth to bedrock	less than 50 cm	greater than 50 cm	greater than 50 cm	greater than 50 cm
texture	fine	fine	fine	fine
coarse fragments	stony	stony	stony	stony
permeability	slow	slow	slow	slow
reaction	alkaline	alkaline	alkaline	alkaline
salinity	-	-	-	-
available water capacity	low	low to moderate	low to moderate	low to moderate
drainage class	well drained	well drained	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE				
inherent productive capacity	low	moderate to high	moderate to high	moderate to high
susceptibility to erosion	moderate	low	low	low
most intensive land use	pastureland	cropland	cropland	cropland

RPU 28

GENERAL DESCRIPTION:

RPU 28 consists of the narrow coastal plain extending from Lattakia south along the Mediterranean coast; it widens inland south of Tartous. The RPU consists of sedimentary rocks overlain by alluvial materials from streams originating in the mountains. The RPU covers an area of 92,600 hectares. Elevation ranges from sea level to approximately 100 m.

The RPU is relatively uniform and comprises a single PPA.

PRODUCTION POTENTIAL AREAS:

The PPA is a level to undulating coastal plain dissected by small intermittent streams with headwaters in the Jebel al-Ansariye. The soils on most of the plain are Typic Pelloxererts; at the southern extremity of the plain they are Typic Chromoxererts. These are deep alkaline clays that are moderately slowly permeable; commonly they are stony. The clays are very hard and cracked and dry and are sticky and plastic when wet. The PPA is suited for use as cropland where stoniness is not excessive. The soils are productive but would require careful management including the use of supplemental irrigation for optimum yields.

The mean annual temperature range is 18^{o} to 19^{o}C and annual precipitation ranges form 800 mm to 1,000 mm. The average monthly temperature during the wet season (Nov. through Mar.) is 12-16^{o}C and monthly rainfall averages 143 mm. No frost has been recorded.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops which were seen or reported include: cabbage, corn, citrus, sunflowers, poplars, eucalyptus, figs, grapes, wheat, olives, beans, onions, tomatoes, lettuce, loquats, polebeans, tobacco, cucumbers, luffa, potato, sugarcane, eggplant, and ground nuts.

The natural vegetation includes the following:

Cupressus sempervirens
Styrax officinalis
Laurus nobilis
Arbutus andrachne
Phillyrea media
Cistus villosus
Spartium junceum
Cytisus villosus
Ruscus aculeatus
Rhus cotinus
Lonicera etrusca
Pistacia palaestina
Erica verticillata
Jasminum fruticans
Ephedra campylopoda
Dryopteris australis
Stipa bromoides
Orchidaceae
Quercus aegilops
Quercus calliprinos
Quercus infectoria
Sarcopoterium spinosum
Ceratonia siliqua
Nerium oleander
Myrtus communis
Hyparrhenia hirta
Pollinia distachya
Urginea maritima
Cephalaria joppica
Clematis flamula
Asparagus aphyllus
Oystris alba
Phlomis longifolia
Origanum syriacus (marus)
Smilax aspera

WATER RESOURCES AND USES:

Hydrologically, this RPU is tied closely to RPUs 30 and 35 and the western section of 25 since several coastal streams and springs originate in these RPUs. One planned reservoir - capacity of 4 million m^3 - would be located near Lattakia to the south. The water would be used for domestic purposes. Two gauging stations are in this RPU. One on the Sinn River measures 378 million m^3 of which 330 million m^3 are from El Sinn. Banias station showed an average annual flow of 54 million m^3.

Three irrigation networks are involved in this RPU. Akkar Plain has a proposed network to irrigate 15,000 hectares. Another proposed network to irrigate 13,000 hectares around Lattakia is partly in this RPU. The third is Sinn where 9,000 hectares are reported irrigated. Seven springs are located in this RPU. Measurements on five springs total 16,813 l/sec, an average of 3,363 l/sec. One of these springs, Sinn, averages 10,485 l/sec.

Four test wells averaged 210 m deep, with a static water level of 48 m and a dynamic level of 83 m. Average yield was 18.1 m^3/hr. These wells are in limestone formation. Seven Water Basin Administration wells averaged 289 m, 24 m, and 47 m, respectively, with average test yield of 6.9 m^3/hr. In addition to the networks, a substantial area is irrigated from wells.

CROP RECOMMENDATIONS:

The maritime nature of RPU 28 (a single PPA) makes it subtropical with regard to many plant species, and its potential for introduced crops is worth considering. With respect to major crops, the RPU has high potential for production of citrus, olives, oil crops, nonrosaceous fruit trees, vegetables, and some pulses, and medium potential for grapes and small grains. Although most of these can be grown using rain as the source of moisture, irrigation will be necessary in some cases to assure optimial yields.

PPA PROPERTIES	28-1
GENERAL	
elevation	0-100 m
dominant range of slope	0-3%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	800-1,000 mm# (863 mm)
average temperature	18-19°C#
- Wet Season Characteristics	
average monthly precipitation	>125 mm@ (143 mm)
average monthly temperature	12-16°C+
period of wet season	November through March
SOILS	
principal components	Typic Pelloxererts Typic Chromoxererts
depth to bedrock	more than 1.5 m
texture	fine
coarse fragments	stony
permeability	slow
reaction	alkaline
salinity	-
available water capacity	low
drainage class	well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	moderate to high
susceptibility to erosion	low
most intensive land use	cropland

RPU 29

GENERAL DESCRIPTION:

PPA 29 is the southeasternmost segment of the Jebel el-Ansariye. It is similar in topography to RPU 30 but the elevations (400-1000 m) are somewhat lower, local relief somewhat less. Total area of this RPU is approximately 24,800 hectares. Different patterns of rainfall distribution characterize this RPU.

RPU 29 consists of only PPA 29-1.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is from 16^{o} to 17^{o}C. Annual precipitation ranges from 800 mm to 1,400 mm. The wet season (Nov. through Mar.) averages less than 90 mm per month rainfall, and monthly temperature averages 9-11^{o}C.

Soils are Lithic Rhodoxeralfs, like those of RPU #30. Local areas of soils slightly more than 50cm deep are common.

The PPA has very little potential for agricultural use. Like RPU #30, much has been terraced over the centuries and the terraced slopes are used for subsistence farming. The local, deeper areas of soil have a slightly greater potential for farm use but none are suited for extensive or intensive cultivation. The PPA is best suited for use as woodland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Information sources indicated that silkworm farming is practiced in RPU 29. Thus, in addition to wheat, potatoes (intercropped with cherries), fruit trees, and figs, mulberry trees, (Morus sp.) are also treated as crops.

The vegetation is listed by species below:

Cupressus sempervirens
Styrax officinalis
Laurus nobilis
Arbutus andrachne
Phillyrea media
Cistus villosus
Spartium junceum
Cytisus villosa
Ruscus aculeatus
Rhus cotinus
Lonicera etrusca
Pistacia palaestina
Erica verticillata
Jasminum fruticans
Osyris alba
Ephedra campylopoda
Phlomis longifolia
Origanum syriacus (marus)
Smilax aspera
Orchidaceae

Quercus aegilops
Quercus calliprinos
Quercus infectoria
Sarcopoterium spinosum
Ceratonia siliqua
Nerium oleander
Myrtus communis
Hyparrhenia hirta
Pollinia distachya
Urginea maritima
Cephalaria joppica
Clematis flammula
Asparagus aphyllus
Celtis tournefortii
Fraxinus spp.
Loranthus europaeus
Dryopteris australis
Stipa bromoides
Avena pratensis
Lathyrus cassius

Sambucus ebulus
Geranium libanoticum
Pteris aquilina
Festuca laevis

WATER RESOURCES AND USES:

This small RPU is naturally forested with little potential for agriculture. No reservoirs have been constructed or planned for the area. Five springs are shown with a total average flow of 406 l/sec.

Three test wells were drilled recently as part of the Water Basin Administration study. These wells are drilled to an average depth of 322 m. One well showed a static level of 33 m and a yield of 34.4 m^3/hr. Small areas may be irrigated from wells or springs but details are lacking.

CROP RECOMMENDATIONS:

PPA 29-1, where modified by terracing, would have high potential for rosaceous fruit trees, small grains, oil crops, or tuber/bulb crops under rainfed conditions. Irrigation, considering the topography, would be difficult.

PPA PROPERTIES	29-1
GENERAL	
elevation	400-1000 m
dominant range of slope	25-45%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	800-1,400 mm#
average temperature	16-17^{o}C#
- Wet Season Characteristics	
average monthly precipitation	< 90 mm@
average monthly temperature	9-11^{o}C^{+}
period of wet season	November through March
SOILS	
principal components	Lithic Rhodoxeralfs,
depth to bedrock	less than 50 cm
texture	medium to fine
coarse fragments	very stony
permeability	moderate
reaction	alkaline
salinity	-
available water capacity	low
drainage class	well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low
susceptibility to erosion	high
most intensive land use	woodland

RPU 30

GENERAL DESCRIPTION:

RPU 30 consists of two regions, one of which borders the Mediterranean Sea in the extreme northwest part of Syria, the other is east of Lattakia and consists of Jebel al-Ansariye and the adjoining footslopes, which separate the coastal plain from the interior of Syria. The valleys are V-shaped and commonly have little or no alluvial plains. Elevations range from 160-1600 m; the local relief varies from 100-250 m. The total area of RPU 30 is 337,100 hectares.

RPU 30 is not divided into PPAs, but there are areas within it which differ climatically. As our Syrian counterparts reminded us, there are interesting edaphic and topographic pockets of vegetation types. Most forested RPUs with much variation in elevation will exhibit some zonation of vegetation types.

PRODUCTION POTENTIAL AREAS:

The climate is characterized by rainfall generally between 800 and 1,400 mm annually and an annual average temperature in the range of 13-19°C. The area has a single wet season extending from November through March. The more sharply defined wet season with slightly higher average monthly rainfall occurs in that part of the RPU which is north of the latitude of Banias and at higher elevations. Maximum precipitation occurs in the vicinity of Jowbet Bourghal and decreases in all directions from this location.

The dominant soils are Lithic Rhodoxeralfs, steeply sloping, shallow, very stony reddish soils of medium texture. They are moderately permeable and have low available moisture. Areas with no soil cover over the underlying limestone bedrock are common, particularly on the steeper slopes of stream valleys and gorges.

The PPA has virtually no potential for mechanized agriculture, although some of it has been terraced for centuries and is now used for farming. Shallowness, stoniness, and steepness generally preclude any use other than this, or as woodland or pasture land.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Fruit trees, olives, tobacco, wheat, figs, tomatoes, pomegranates, faba beans, and onions have been seen or observed as crops.

The vegetation in RPU 30 include the plants listed below:

Cupressus sempervirens
Styrax officinalis
Laurus nobilis
Arbutus andrachne
Phillyrea media
Cistus villosus
Spartium junceum
Cytisus villosus
Ruscus aculeatus
Cotinus coggygria
Lonicera etrusca
Pistacia palaestina

Quercus cerris
Juniperus drupacea
Fraxinus ornus
Ostrya carpinifolia
Hedera helix
Paeonia corallina
Luzula foresteri
Pinus sp.
Silene libanotica
Smilax sp.
Quercus aegilops
Quercus calliprinos

Erica verticillata
Asparagus aphyllus
Jasminum fruticans
Osyris alba
Ephedra campylopoda
Phlomis longifolia
Dryopteris australis
Origanum syriacus (marus)
Stipa bromoides
Smilax aspera
Orchidaceae
Bougainvillea sp.
Abies silicica
Quercus infectoria
Sarcopoterium spinosum
Ceratonia siliqua
Nerium oleander
Myrtus communis
Hyparrhenia hirta
Pollinia distachya
Urginea maritima
Cephalaria joppica
Clematis flammula
Hypericum sp.
Cedrus libani
Pistacia lentiscus

WATER RESOURCES AND USES:

As noted in RPU 28, this area is the water source for the coastal irrigated areas. One reservoir east of Lattakia, capacity 3 million m^3, is for domestic use. The other completed reservoir is in the section adjacent to Turkey, capacity 7.37 million m^3 for irrigation. Three other reservoirs under construction south and east of Lattakia are for irrigation and domestic use and have a total capacity of 21.435 million m^3. Four reservoirs, capacity 22.75 million m^3, are planned for completion by 1981 - one for domestic use, the others for irrigation. RPU 30 apparently includes a strip of the Orontes Basin.

Seven springs are located in the Coastal Basin of RPU 30; flow is available only for one, at 500 l/sec. Fifteen springs are in the Orontes Basin portion of RPU 30; these springs, of course, drain to the east and eleven of them have a total annual flow of 3,863 l/sec. One government test well is in RPU 30 - Orontes, and twelve test wells are in the Coastal Basin. Nine test wells averaged 236 m in depth. Test information on three of these wells showed a static level of 114 m, a dynamic level of 148 m, and yield of 14.9 m^3/hr. The other four wells were under the Water Basin Administration and averaged 390 m, 75 m, 151 m, and 3.3 m^3/hr.

Some irrigated crops are grown along with larger areas of rainfed crops. Three manatik occur in the RPU. One of them, Safitia, reports a fairly substantial area of irrigated crops.

CROP RECOMMENDATIONS:

RPU 30, whose climate varies over short distances with altitude and exposure, is suited for reforestation, although in terraced areas agriculture has been traditionally practiced in these highlands.

PPA PROPERTIES	30-1
GENERAL	
elevation	160-1600 m
dominant range of slope	15-45%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	800-1,400 mm# (1,017-1,590 mm)
average temperature	13-19°C# (16.4-18.2°C)
- Wet Season Characteristics	
average monthly precipitation	<180 mm@ (163-259 mm)
average monthly temperature	7-14°C+
period of wet season	November through March
SOILS	
principal components	Lithic Rhodoxeralfs, bare rock
depth to bedrock	less than 50 cm
texture	medium
coarse fragments	very stony
permeability	moderate
reaction	alkaline
salinity	-
available water capacity	low
drainage class	well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low
susceptibility to erosion	high
most intensive land use	woodland

RPU 31

GENERAL DESCRIPTION:

RPU 31 is the most extensive RPU in Syria, covering nearly one fourth of the country. It is a broad desert plain extending from a short distance southeast of Aleppo and east of Palmyra to the eastern border of the country, and characterized by soils having high contents of gypsum. It is an area of approximately 4,155,600 hectares. Elevation ranges from 215-475 m. The majority of the RPU is hot and dry during the summer and cool and moist during the winter. The northwestern part of the RPU near Aleppo is similar but has more rainfall. The mean annual temperature range is 16^{o} to 21^{o}C. Annual precipitation ranges from 100 mm to 300 mm.

The RPU has four coarsely patterned PPAs distinguished by differences in precipitation and the presence or absence of gypsum. Because of the overriding effect on plant growth of a high proportion of gypsum, no attempt has been made to distinguish among areas of gypsiferous soils on the basis of differences in soil depth or of slope.

PRODUCTION POTENTIAL AREAS:

PPA 31-1 includes the nearly level to rolling gypsiferous soils, Typic Gypsiorthids, and Petrogypsic Gypsiorthids. All of the soils are coarse textured and have low water holding capacities. Stoniness is common. The Petrogypsic Gypsiorthids are shallow to a petrogypsic layer (soil layer cemented with gypsum), but the other soils are deep. Content of gypsum (calcium sulfate) is high and the material in many places is fluffy. These soils have low levels of productivity, mainly because of the high gypsum content, and among the petrogypsic ones because of shallowness to the cemented layer.

PPA 31-1 has little potential for agricultural use. The soils are deficient in nitrogen, phosphorus is not readily available to plants, and moisture is not available in quantities required for most crops. The PPA is best suited for use as rangeland for the limited amount of grazing it would afford. The climate is characterized by an annual precipitation of 100-200 mm. During the wet season (Oct. through May) the average monthly precipitation is 14-18 mm.

PPA 31-2 includes level to slightly undulating plains distributed throughout the RPU. The principal soils are Typic Torriorthents, like those in PPA 17-1. These are deep, coarse and medium textured soils that are generally stone free. Deflation by desert winds has removed fine material from the surface leaving a thin cover of flint fragments on the surface. The soils are well drained, moderately to rapidly permeable, and have low to moderate available moisture. Some parts of the PPA are slightly saline.

PPA 31-2 would be suited for use as cropland if adequate supplies of water for irrigation could be made available. However, careful management would be required to prevent a build-up of salinity. Without irrigation, the PPA would be suited only for use as rangeland. The climate of PPA 31-2 is similar to that of PPA 31-1.

PPA 31-3 includes the nearly level to rolling gypsiferous soils, Typic Gypsiorthids, Calcic Gypsiorthids, and Petrogypsic Gypsiorthids. All of the soils are coarse-textured and have low water holding capacities. Stoniness is common. The Petrogypsic Gypsiorthids are shallow to a petrogypsic layer (soil layer cemented with gypsum), but the other soils are deep. Content of gypsum (calcium sulfate) is high and the material

in many places is fluffy. These soils have low levels of productivity, mainly because of the high gypsum content and among the petrogypsic ones because of shallowness to the cemented layer.

PPA 31-3 has little potential for agricultural use. The soils are deficient in nitrogen, phosphorus is not readily available to plants, and moisture is not available in quantities required for most crops. The PPA is best suited for use as rangeland for the limited amount of grazing it would afford. The annual precipitation ranges from 100-300 mm. During the wet season (Oct. through May) the average monthly precipitation is less than 60 mm.

PPA 31-4 includes level to slightly undulating plains distributed throughout the RPU. The principal soils are Typic Torriorthents, like those in PPA 31-2. These are deep, coarse and medium textured soils that are generally stone free. Deflation by desert winds has removed fine material from the surface leaving a thin cover of flint fragments on the surface. The soils are well drained, moderately to rapidly permeable, and have low to moderate available moisture. Some parts of the PPA are slightly saline.

PPA 31-4 would be suited for use as cropland if adequate supplies of water for irrigation could be made available. However, careful mangement would be required to prevent a build-up of salinity. Without irrigation, the PPA would be suited only for use as rangeland. The climate of PPA 31-4 is similar to that of PPA 31-3.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Inextensive areas of irrigated and dryland farming were reported for this RPU. Irrigated farming takes place in the western portion of the RPU, primarily in the expansive area of the Euphrates irrigation projects. Dryland farming also takes place in the western portion of the RPU, where rainfall tends to be adequate at times.

The flora of the RPU is listed, in part, below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Spergularia diandra
Senecio desfontainei
Plantago notata
Silene coniflora
Salsola vermiculata
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Adonis dentata
Salsola inermis
Carex spp.
Poa spp.
Erodium pulverulentum
Helianthemum sessiliflorum
Heliotropium persicum
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshonii
Haloxylon glaucophyllum
Erodium glaucophyllum
Achillea conferta

Leontodon hispidulus
Scabiosa aucheri
Scleropoa dichotoma
Aristida plumosa
Astragalus duplostrigosus

WATER RESOURCES AND USES:

This RPU includes land and water resources in six hydrologic subbasins with 1, 8 and 9 being the main ones. About half the land is estimated as suitable for crop production under irrigation, but the soils pose serious gypsum and salinity problems.

Three reservoirs are shown in available data. They have a total capacity of 4.85 million m^3 and all water is for domestic use. One reservoir, Hydro Subbasin 9, stored no water in 1978. The other two are in Hydro Subbasin 8; one was filled to 22 percent capacity, and information is not available on the other one. Two other reservoirs (capacity 1.6 and 20.0 million m^3) are planned for completion by 1981; one is upstream from Deir-ez-Zor and the other is near the border east from this city. No springs are shown in this RPU, but there are scattered wells in the desert for domestic and livestock use.

Twenty-two government test wells are in the study sample - all are in the desert except one in Jezireh and three near Aleppo. These wells averaged 255 m deep. Test information on 16 wells showed 42 m static water level, 62 m dynamic level, and 16.3 m^3/hr yield. They were in several formations -- limestone, marls, and sand.

This RPU includes two major segments of the Euphrates Reclamation Project and a portion of the Meskeneh Unit. The Project will supply water for irrigated crop production. The Lower Khabour area comprises 70,000 hectares and Meyadine Plain comprises 40,000 hectares but development has not commenced in these areas.

CROP RECOMMENDATIONS:

RPU 31 is a wasteland devoid of potential for rainfed agriculture. Because of the overriding effect of a high content of gypsum PPA 31-1 and PPA 31-3 would not be significantly improved by irrigation. PPAs 31-2 and PPA 31-4, with irrigation, would have high potential for small grains and pulses.

PPA PROPERTIES	31-1	31-2	31-3	31-4
GENERAL				
elevation	215-475 m	215-475 m	215-475 m	215-475 m
dominant range of slope	0-15%	0-3%	0-15%	0-3%
portion of RPU	45%	45%	5%	5%
CLIMATE				
- Annual Characteristics				
average precipitation	100-200 mm# (116-141 mm)	100-200 mm# (116-141 mm)	100-300 mm#	100-300 mm#
average temperature	16-21°C# (18.9°C)	16-21°C# (18.9°C)	16-21°C#	16-21°C#
- Wet Season Characteristics				
average monthly precipitation	< 38 mm@ (14-18 mm)	< 38 mm@ 14-18 mm)	< 60 mm@	< 60 mm@
average monthly temperature	11-16°C+	11-16°C+	13-14°C+	13-14°C+
period of wet season	October through May	October through May	October through May	October through May
SOILS				
principal components	Typic Gypsiorthids Calcic Gypsiorthids Petrogypsic Gypsiorthids	Typic Torriorthents	Typic Gypsiorthids Calcic Gypsiorthids Petrogypsic Gypsiorthids	Typic Torriorthents
depth to bedrock	less than 50 cm	greater than 50 cm	less than 50 cm	greater than 50 cm
texture	coarse	coarse and medium	coarse	coarse and medium
coarse fragments	stony	nonstony	stony	nonstony
permeability	rapid	rapid to moderate	rapid	rapid to moderate
reaction	alkaline	alkaline	alkaline	alkaline
salinity	slightly saline	slightly saline	slightly saline	slightly saline
available water capacity	low	low to moderate	low	low to moderate
drainage class	well drained	well drained	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE				
inherent productive capacity	low	low	low	low
susceptibility to erosion	low	low	low	low
most intensive land use	rangeland	cropland, irrigated	rangeland	cropland, irrigated

RPU 32

GENERAL DESCRIPTION:

RPU 32 is that part of the valley of the Euphrates River which is generally downstream from the Euphrates dam. It includes not only the flood plain but also adjacent river terraces. It is an area of approximately 343,000 hectares at elevations of approximately 175-250 m.

The RPU consists of two finely patterned PPAs, distinguished on the basis of physiographic position.

PRODUCTION POTENTIAL AREAS:

PPA 32-1 is the level floor of the Euphrates valley. The soils are Xeric Torrifluvents. They are deep, fine-textured, moderately well drained, moderately slow permeable soils. They are alkaline and slightly saline. Flooding occurs only rarely. The soils are productive and the PPA is suited for use as cropland. Irrigation is necessary for optimum yields but careful management is required to prevent build-up of toxic levels of salinity.

PPA 32-2 includes the fringing higher-lying discontinuous areas in terrace positions along the lower reaches of the Euphrates River. The soils are Typic Torriorthents; they are mostly coarse textured and nonstony, and have low moisture holding capacity and rapid permeability. They are alkaline and slightly saline. These soils are moderately productive and the PPA is suited for use as cropland. Soil amendments would be needed to increase and maintain productivity. Irrigation would be required for optimum yields but careful management would be required to prevent build-up of salinity levels.

The mean annual temperature range is 18° to 21°C. Annual precipitation ranges from 100 mm to 250 mm. The average monthly precipitation is 13-25 mm during the wet season (Oct. through May).

REPORTED OR OBSERVED CROPS OR VEGETATION:

Cotton, corn, fruit trees, grain, pistachio, grapes, sugar beets, poplars, eucalyptus, and vegetables are raised in RPU 32.

The flora includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Helianthemum sessiliflorum
Heliotropium persicum
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshoni
Artemisia scoparia
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Astragalus duplostrigosus
Quercus sp.

Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Scabiosa aucheri
Carex spp.
Parthenocissus sp.
Robinia sp.
Melia azedarach
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa sp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Campsis radicans
Ricinus communis
Poa spp.

WATER RESOURCES AND USES:

Drainage and leaching water are essential for irrigated crop production here. About 40 percent of the land is irrigated by pumping from the Euphrates River with numerous pumps on an individual or small group basis.

The Euphrates reservoir in RPUs 32 and 40 has a capacity of 12 billion m^3; it is to be used to irrigate 640,000 hectares of land, for flood control, and to generate a substantial amount of hydroelectric power.

No springs or test wells are in this RPU. The intent is that the 140,000 hectares reportedly now irrigated in RPU 32 will become part of the Euphrates Project lands, though provision will have to be made for land leveling, drainage, and leaching water because of the salinity problem.

Water-utilizing industries in the area include sugar factors at Al-Rakka and Deir-ez-Zor and a pulp mill and cotton cloth plant in Deir-ez-Zor. The RPU is an important sheep and goat raising area.

CROP RECOMMENDATIONS:

RPU 32 is the climatically drier and hotter part of the Euphrates valley. Nearly all water for agriculture comes from the great river itself. The two soil-based PPAs are quite similar in agricultural potential. With irrigation, they have high potential for small grains, tuber/root crops, cotton, grapes, and vegetables, and medium potential for pulses and fruit trees.

PPA PROPERTIES	32-1	32-2
GENERAL		
elevation	175-250 m	175-250 m
dominant range of slope	0-3%	0-8%
portion of RPU	75%	25%
CLIMATE		
- Annual Characteristics		
average precipitation	100-250 mm# (101-207 mm)	100-250 mm# (101-207 mm)
average temperature	18-21°C# (18.6-20.2°C)	18-21°C# (18.6-20.2°C)
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@ (13-25 mm)	< 38 mm@ (13-25 mm)
average monthly temperature	13-16°C+	13-16°C+
period of wet season	October through May	October through May
SOILS		
principal components	Xeric Torrifluvents	Typic Torriorthents
depth to bedrock	more than 1 m	more than 1 m
texture	fine	coarse
coarse fragments	nonstony	nonstony
permeability	moderate	rapid
reaction	alkaline	alkaline
salinity	slightly saline	slightly saline
available water capacity	moderate	low
drainage class	moderately well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate to high	moderate
susceptibility to erosion	low	low to moderate
most intensive land use	cropland (irrigated)	cropland (irrigated)

RPU 33

GENERAL DESCRIPTION:

RPU 33 is mainly an area of shallow saline depressions, and level to undulating plains dominated by gypsiferous soils. Lying in the far east-central part of the country it is estimated at 60,400 hectares in total area. Elevation ranges from 150-200 m.

RPU 33 is divided into two coarsely patterned PPAs because of differences in the principal soils and in their topographic positions.

PRODUCTION POTENTIAL AREAS:

PPA 33-1 is the more extensive of the PPAs, covering approximately 70 percent of the RPU. The area is primarily one of salty depressions, the dry beds of ephemeral desert lakes which may be briefly wet or ponded after rains but are dry at the surface and covered by a saline crust over much of their areas most of the time. The principal soils are Typic Halaquepts and associated soils formed from an accumulation of alluvial and colluvial materials over limestone or marl. The high salinity of these soils allows little potential for agriculture in these areas. Except on some of the higher lying areas between depressons the soils are almost devoid of vegetation.

PPA 33-2 consists of level to undulating desert plains on which Petrogypsic Gypsiorthids and their associates are the principal soils. Such soils are very limited in productive potential. The indurated soil horizon (petrogypsic layer) is a barrier to plant root development and even where penetration is achieved naturally or through subsoiling, plant nutrients are seriously deficient because of chemical unavailability beneath the cemented horizon. Sparse native grasses provide poor grazing in this PPA.

The mean annual temperature range is 19° to 21°C. Annual precipitation ranges from 100 mm to 150 mm. The average monthly precipitation is less than 38 mm in the wet season (Oct. through May).

REPORTED OR OBSERVED CROPS AND VEGETATION:

No cultivation was reported for this RPU.

A plant list of some species found in this RPU follows:

Tamarix spp.
Frankenia spp.
Halocnemum strobilaceum
Salicornia herbacea
Salsola crassa
Statice palmyrensis
Aelurepus littoralis
Sphenopus divaricatus
Juncus maritimus
Helianthemum sessiliflorum
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Artemisia herba-alba
Heliotropium persicum
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshonii
Artemisia scoparia

Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Silene coniflora
Salsola vermiculata
Peganum harmala
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Scleropoa dichotoma
Plantago notata
Erodium pulverulentum
Poa sinaica
Astragalus tribuloides
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus
Astragalus duplostrigosus

WATER RESOURCES AND USES:

No reservoirs, springs, or wells occur in this RPU and there are no prospects for future water development.

CROP RECOMMENDATIONS:

RPU 33 is suited only to limited use. PPA 33-2 has little agricultural potential at current reasonable technological levels. PPA 33-1 is too saline for most conventional (or major) crops, even with irrigation. Only salt-tolerant crops, such as salt bush (Atriplex spp.) or mesquite (Prosopis spp.), can be expected to produce acceptable yields.

PPA PROPERTIES	33-1	33-2
GENERAL		
elevation	150-200 m	150-200 m
dominant range of slope	0-3%	3-5%
portion of RPU	70%	30%
CLIMATE		
- Annual Characteristics		
average precipitation	100-150 mm#	100-150 mm#
average temperature	19-21°C#	19-21°C#
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@	< 38 mm@
average monthly temperature	14-16°C+	14-16°C+
period of wet season	October through May	October through May
SOILS		
principal components	Typic Halaquepts	Petrogypsic Gypsiorthids
depth to bedrock	1.5-2 m	25-50 cm
texture	moderately fine	moderately coarse
coarse fragments	nonstony	nonstony
permeability	moderate	moderate
reaction	mildly alkaline	mildly alkaline
salinity	strongly saline	slightly saline
available water capacity	moderate	low
drainage class	poorly drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	very low	low
susceptibility to erosion	slight	moderate
most intensive land use	rangeland	rangeland

RPU 34

GENERAL DESCRIPTION:

RPU 34 in northwest Syria is primarily the Ghab Valley, the level to undulating flood plain and terraces of the Orontes River which lie within the Rift Valley at the foot of the Jebel al-Ansariye. This great depression totals more than 86,000 hectares with elevations ranging mainly from 150 to 220 m with very low relief. The mean annual temperature range is from 17^{o} to 19^{o}C. Annual precipitation ranges from 500 mm to 1,000 mm.

RPU 34 has been divided into two coarsely patterned PPAs because of climatic differences.

PRODUCTION POTENTIAL AREAS:

PPA 34-1 is the southernmost segment of the RPU. The precipitation ranges from 500 to 750 mm annually. The monthly precipitation averages more than 60 mm in the wet season (Nov. through Mar.).

PPA 34-2 encompasses most of RPU 34 except for the southernmost east-west segment. The annual precipitation averages 500-1,000 mm. During the wet season (Nov. through Mar.) the average monthly precipitation is 85-119 mm.

In PPAs 34-1 and 34-2 the soils are Aeric Haplaquepts, soils that are somewhat better drained than normally expected for soils in such a depressed topographic position. More poorly drained soils (Typic Haplaquepts) in small areas are associated. The soils are deep, clayey, mildly alkaline and slightly saline. A system of drainage ditches and canals minimizes the likelihood of flooding.

These PPAs are suited to mechanized agriculture. Adequate moisture, fertility and soil depth provide good potential for use as cropland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops that were reported, or seen, were: wheat, olives, figs, pistachio, corn, grapes, fruit trees, cotton, sugar beets, cabbage, sunflowers, poplars, and eucalyptus.

The vegetation believed to occur in the Ghab Valley is listed below:

Astragalus spinosa
Thymus syriacus
Noaea mucronata
Hordeum bulbosum
Dactylis hispanica
Bromus danthoniae
Cousinia spp.
Centaurea spp.
Carthamus spp.
Anchusa spp.
Alkanna spp.
Phlomis spp.
Onoperdon anisacanthum
Phalaris spp.

Phragmites communis
Typha latifolia
Scirpus tuberosus
Cyperus longus
Ranunculus aquatilis
Nuphar luteum
Eleocharis palustris
Conifers
Salix sp.
Morus sp.
Ricinus communis
Rosa odorata
Salvia spp.
Silene coniflora

Echinops blanchaenus
Euphorbia spp.
Hypericum triquetrifolium

WATER RESOURCES AND USES:

The Asharneh Plain and Ghab Valley, which comprise this RPU, are among the major irrigated areas of Syria. Large areas of winter rainfed crops, occasionally supplemented by one or two irrigations, also are produced. The Orontes River is the major source of water, by both surface and return flows. Springs also supply a major quantity of water. Nine springs are shown in the RPU for a total average annual flow of 7,918 l/sec. There are no reservoirs.

A gauging station located at the lower end of the valley shows a total annual average flow of 1,009 million m^3. This flow is highly significant since it represents a quantity of water that is lost to the sea.

Major water resource developments are being considered and studies are underway for various kinds of reclamation related to irrigated agriculture. In other RPUs, much of the water leaving the valley comes from springs that cannot be used during winter months or may not be situated to permit ready use at this time.

Two irrigation networks -- Ghab (50,000 hectares) and Asharneh (20,000 hectares) are in this RPU. The Asharneh gravity canal from Mahardah Dam is shown as serving 18,934 hectares of irrigated land; the capacity of this canal is 14 m^3/sec. Four major canals, capacity 26 m^3/sec, serve the Ghab Valley and are designed to service about 46,000 hectares of irrigated land. There are also many wells in the Asharneh Plains in contrast to the Ghab, where there are relatively few wells but large water supplies from springs.

Nine government test wells are included in this study. Three test wells averaged 160 m deep, 51 m static level, 92 m dynamic level and 12.0 m^3/hr yield; one well was in basalt and one in limestone formation. The other six wells were Water Basin Administration study wells and they average 251 m, 12 m, 35 m, and 3.2 m^3/hr.

The Ghab Mantika, which apparently includes both Asharneh and Ghab Valley, reports 34,526 hectares of irrigated crops (1975-77 average), with cotton (19,000 hectares) by far the largest single irrigated crop. Additional areas reportedly receive at least supplementary irrigation.

The conjunctive uses of surface water and springs is a highly important feature in this RPU. A sugar factory in the Ghab Valley is among the large water using plants in Syria.

CROP RECOMMENDATIONS:

PPAs 34-1 and 34-2 are rather similar in terms of adapted crops, even though they reflect climatic differences which would be expected to influence yield levels of these crops. Under irrigation, the RPU has high potential for production of small grains, tuber/root crops, high to medium potential for fruit trees (nonrosaceous) and pulses and medium potential for olives, vegetables, cotton, and rosaceous fruit trees. Without irrigation, the RPU would have less potential for these crops.

PPA PROPERTIES	34-1	34-2
GENERAL		
elevation	150-220 m	150-220 m
dominant range of slope	0-3%	0-3%
portion of RPU	50%	50%
CLIMATE		
- Annual Characteristics		
average precipitation	500-750 mm#	500-1,000 mm# (516-717 mm)
average temperature	17-19°C# (18.1°C)	17-19°C# (18.0-18.5°C)
- Wet Season Characteristics		
average monthly precipitation	> 60 mm@ (83 mm)	> 90 mm@ (85-119 mm)
average monthly temperature	10-11°C+	10-11°C+
period of wet season	November through March	November through March
SOILS		
principal components	Aeric Haplaquepts	Aeric Haplaquepts
depth to bedrock	1.5-2.0 m	1.5-2.0 m
texture	fine	fine
coarse fragments	nonstony	nonstony
permeability	moderate	moderate
reaction	mildly alkaline	mildly alkaline
salinity	slightly saline	slightly saline
available water capacity	moderate	moderate
drainage class	moderately well	moderately well
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	high	high
susceptibility to erosion	slight	slight
most intensive land use	cropland	cropland

RPU 35

GENERAL DESCRIPTION:

RPU 35 consists of a single area that extends 45 kilometers northeastward from Lattakia to the northern border and northward along the coast for about 25 kilometers. Its area is estimated to be about 42,500 hectares. The RPU is composed of two topographically distinct areas. The smaller is the level coastal plain of about 10,000 hectares north of Lattakia; the larger is a hilly region that lies along the coast to the north of the coastal plain and also to the northeast of the city. Elevations range from sea level to more than 600 m with local relief from a few to more than 200 m. The RPU has mild rainy winters, and warm dry summers. The mean annual temperature is 17^{o} to 19^{o}C. Annual precipitation ranges from 600 mm to 1,200 mm.

RPU 35 is divided into three coarsely patterned PPAs on the basis of topography and rainfall distribution.

PRODUCTION POTENTIAL AREAS:

PPA 35-1 is the coastal plain area, about 10 percent of the RPU. Its principal soils are typic Pelloxererts, dark colored, somewhat stony and fine-textured soils of moderate depth and moderate fertility as related to probable base saturation. The level plain is suitable for mechanized farming and erosion is not a problem. This PPA has moderate to high potential for agricultural development as cropland.

The climate is characterized by an average annual precipitation in the range of 600 to 1000 mm. During the wet season (Oct. through Mar.) the average monthly precipitation is about 125 mm.

In PPA 35-2, the soils are the same as those in PPA 35-1. It is wetter than PPA 31-1, receiving 600-1,200 mm precipitation annually. During the wet season (Oct. through Mar.) the average monthly precipitation exceeds 180 mm.

PPA 35-3 is the most extensive PPA in the RPU. It is a hilly region of this RPU of very limited potential for agriculture. The chief soils are Lithic Xerorthents that have somewhat fine-textured soils that are shallow to marl and limestone. As much as 30 percent of the area is seriously eroded and is highly calcareous, and outcrop areas of rock are common. Although there is some cultivation of wheat and barley, this PPA is little suited to cultivation. Potential for more intensive use than pasture and woodland is quite limited.

Annual precipitation in PPA 35-3 generally ranges from 800 to 1,200 mm and average annual temperatures range from 17-19^{o}C; lower temperatures and higher rainfall prevail at the higher elevations. During the wet season (Oct. through Mar.) the average monthly precipitation ranges from about 125 mm to over 180 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops located in RPU 35 include apples and other fruit trees, figs, pomegranates, olives, grapes, grain and poplars.

Plants reported or observed are listed below:

Cupressus sempervirens

Quercus cerris

Styrax officinalis
Laurus nobilis
Arbutus andrachne
Phillyrea media
Cistus villosus
Spartium junceum
Cytisus villosus
Ruscus aculeatus
Cotinus coggyria
Lonicera etrusca
Pistacia palaestina
Erica verticillata
Asparagus aphyllus
Jasminum fruticans
Osyris alba
Ephedra campylopoda
Phlomis longifolia
Dryopteris australis
Origanum syriacus (marus)
Stipa bromoides
Smilax aspera
Orchidaceae
Morus sp.
Platanus orientalis
Cercis sp.
Celtis tournefortii
Fraxinus spp.
Loranthus europaeus
Pteris aquilina
Juniperus drupacea
Fraxinus ornus
Ostrya carpinifolia
Hedera helix
Paeonia corallina
Luzula foresteri
Primula acaulis
Viola odorata
Helleborus vesicarius
Anemone blanda
Rubia aucheri
Limonium sp.
Quercus aegilops
Quercus calliprinos
Quercus infectoria
Sarcopoterium spinosum
Festuca laevis
Ceratonia siliqua
Nerium oleander
Myrtus communis
Hyparrhenia hirta
Pollinia distachya
Urginea maritima
Cephalaria joppica
Clematis flammula
Avena pratensis
Lathyrus cassius
Sambucus ebulus
Geranium libanoticum

WATER RESOURCES AND USES:

Network 12 - 13,000 hectares - is largely in this RPU. A dam is proposed on the Al-Kabir Al-Shamali River to store 214 million m^3 and supply water to 14,000 hectares. A gauging station on Al-Kabir showed a flow of 116 million m^3; possibly these readings were in less-than-average precipitation years. Seven reservoirs for irrigation in this RPU showed a total capacity of 18,615,000 m^3. All these reservoirs filled in 1978. Two small reservoirs - 1,340,000 m^3 total capacity - are planned for completion by 1981; one of these reservoirs would be for domestic use.

One spring is located in the area; flow data is now available. This study includes five government test wells. Four regular program test wells averaged 185 m deep, 28 m static water level, 38 m dynamic level, and 26.9 m^3/hr yield. These wells are in limestone-marls formation. The other well, under the Water Basin Administration, was 350 m, 3 m, 64 m, and only 0.8 m^3/hr yield. Some 3,400 hectares of irrigated crops are reported in Lattakia Mantika which is generally the same areas as RPU 35.

CROP RECOMMENDATIONS:

RPU 35 has good potential for some major crops. This potential is, however, not evenly distributed among the three PPAs. Without irrigation, PPA 35-1 has high potential for the production of small grains, and medium potential for production of fruit trees, vegetables, oil crops, and olives; with irrigation it has high potential for all of these crops. PPA 35-2 receives even more rainfall than PPA 35-1, and without

irrigation would have high potential for the production of small grains, olives, fruit trees and oil crops and medium potential for vegetables; with irrigation PPA 35-2 would have high potential for all of these crops.

PPA 35-3's potential for crop production is severely limited by the shallow, stony nature of the soils.

PPA PROPERTIES	35-1	35-2	35-3
GENERAL			
elevation	0-50 m	0-50 m	50-620 m
dominant range of slope	0-3%	0-3%	15-35%
portion of RPU	10%	10%	80%
CLIMATE			
- Annual Characteristics			
average precipitation	600-1,000 mm# (859 mm)	600-1,200 mm#	800-1,200 mm#
average temperature	18-19°C#	18-19°C#	17-19°C#
- Wet Season Characteristics			
average monthly precipitation	> 125 mm@	> 180 mm@	> 125 to > 180 mm@
average monthly temperature	13-16°C^{+}	13-16°C^{+}	11-15°C^{+}
period of wet season	October through March	October through March	October through March
SOILS			
principal components	Typic Pelloxererts	Typic Pelloxererts	Lithic Xerorthents
depth to bedrock	70-100 cm	70-100 cm	20-50 cm
texture	moderately fine	moderately fine	moderately fine
coarse fragments	stony	stony	very stony
permeability	moderately slow	moderately slow	moderate
reaction	neutral	neutral	mildly alkaline
salinity	nonsaline	nonsaline	nonsaline
available water capacity	moderate	moderate	low
drainage class	moderately well drained	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate	moderate	low
susceptibility to erosion	slight	slight	severe
most intensive land use	cropland	cropland	pastureland

RPU 36

GENERAL DESCRIPTION:

RPU 36 consists of three hilly and mountainous areas of northwest Syria in which steep, shallow and rocky limestone soils preclude agricultural potential for cultivated crops, except for scattered small fields where a few crops are nurtured on a subsistence basis. The total area is 207,500 hectares. Elevation ranges from 100 to nearly 900 m with local relief of as much as 600 m.

Although some climatic differences occur in this RPU, the region was not subdivided into several PPAs because the soils were poor and are the limiting factor in plant growth. Thus, the RPU represents PPA 36-1.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 17^{o} to 19^{o}C. Annual precipitation ranges from 400 mm to 1,000 mm. During the wet season (Nov. through Mar.) the average monthly precipitation in different parts of the RPU ranges from 87 to 111 mm.

The principal soils are Lithic Rhodoxeralfs which are very shallow to the limestone bedrock. Nearly half the area has a completely stony surface or is actually the outcropping of the bedrock. The soils have moderately fine texture, low available water capacity and are somewhat excessively drained. Shallowness and steep slopes, in many places over 75 percent, combine to limit the most suitable use of these areas to woodland; locally, areas of slightly deeper soils on moderate and gentle slopes would be suited for more intensive use.

REPORTED OR OBSERVED CROPS AND VEGETATION:

No crops were reported in this RPU; however, olives, grapes, lentils, sugar beets; figs intercropped with olives; wheat intercropped with olives; sunflowers intercropped with tomatoes; and tomatoes intercropped with pomegranates and sunflowers were seen. Additionally, loquats, cabbage, grain, pomegranates, citrus, peppers, okra, corn, sunflowers, radishes, onions, fruit trees, and tobacco were observed.

Vegetation for the RPU appears below and includes observed and reported plants:

Quercus aegilops
Quercus calliprinos
Quercus infectoria
Quercus cerris
Sarcopoterium spinosum
Ceratonia siliqua
Nerium oleander
Myrtus communis
Hyparrhenia hirta
Pollinia distachya
Urginia maritima
Cephalaria joppica
Clematis flammula
Papaver sp.
Pinus spp.
Ailanthus altissima
Cupressus sempervirens
Styrax officinalis
Laurus nobilis
Arbutus andrachne
Phillyrea media
Cistus villosus
Spartium junceum
Cytisus villosus
Ruscus aculeatus
Cotinus coggygria
Lonicera etrusca
Pistacia palaestina
Erica verticillata
Asparagus aphyllus
Jasminum fruticans
Osytris alba

Xanthium sp.
Melia azedarach
Celtis tournefortii
Fraxinus spp.
Loranthus europaeus
Verbascum sp.
Cercis sp.
Polygonum sp.
Lathyrus cassium
Pteris aquilina
Festuca laevis
Ephedra campylopoda
Phlomis longifolia
Dryopteris australis
Origanum syriacus (marus)
Stipa bromoides
Smilax aspera
Orchidaceae
Avena pratensis
Sambucus ebulus
Geranium libanoticum

WATER RESOURCES AND USES:

Apparently the headwaters of the Afrin River are in one section of this RPU. A stream gauging station in the headwaters shows an average annual flow of 162.7 million m^3. One reservoir is under construction in the northeast; it will have a capacity of 15.5 million m^3 and it is scheduled for irrigation and domestic use. It appears that the water would actually be used downstream in another RPU in the Afrin drainage.

Springs occur in all areas. The Orontes basin area has eight springs with total average flows of 175 l/sec. The two areas in Afrin Catchment Basin contain eight springs with a total average annual flow of 354 l/sec. Five government test wells - one Ministry of Public Works and four Water Basin Administration - are in this RPU. The MPW well is 202 m deep, has a static level of 136 m, and a 176 m dynamic level with a yield of 2.5 m^3/hr. It is in limestone formation. The four WBA wells averaged 200 m deep; other information is not available.

The section of this RPU west of Idleb is largely comprised of Harem and Jisr-al-Shuqhour Manatik. Combined, they report 4,100 hectares of irrigated crops - mostly winter wheat, cotton, vegetables and fruit. There may also be irrigated crops in portions of Ifrin Mantika which is in this RPU.

CROP RECOMMENDATIONS:

RPU 36 has medium potential for olives, pulses, grapes, tuber/root crops, fruit trees, citrus, vegetables, and oil crops, but these would be grown mainly on a subsistence basis where soil conditions permit.

PPA PROPERTIES	36-1
GENERAL	
elevation	100-900 m
dominant range of slope	35 to more than 75%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	400-1,000 mm# (553-665 mm)
average temperature	17-19°C#
- Wet Season Characteristics	
average monthly precipitation	< to > 90 mm@ (87-111 mm)
average monthly temperature	8-11°C^{+}
period of wet season	November through March
SOILS	
principal components	Lithic Rhodoxeralfs bare rock
depth to bedrock	10-50 cm
texture	moderately fine
coarse fragments	very stony
permeability	moderate
reaction	mildly alkaline
salinity	nonsaline
available water capacity	low
drainage class	somewhat excessively drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	very low
susceptibility to erosion	severe
most intensive land use	woodland

RPU 37

GENERAL DESCRIPTIONS:

RPU 37 is a single area estimated at 54,400 hectares, lying mainly to the west of the town of Idleb and extending southward along the eastern edge of the Ghab. That part of the RPU closer to the town is of rolling topography; the elongated area along the Ghab and to the northeast is hilly. Both areas have soils that are shallow to the limestone bedrock and have stony surfaces. Elevations for the RPU range from 300-940 m.

RPU 37 is divided into two coarsely patterned PPAs because of the topographic differences.

PRODUCTION POTENTIAL AREAS:

PPA 37-1 is identified as the area of rolling topography near Idleb. The soils are Lithic Xerorthents, vertic phase, which are somewhat heavy-textured, stony, of low available water capacity and shallow to bedrock. Topographic limitations alone are not extreme but coupled with the limiting characteristics of the soil - stoniness, shallowness, and low available water capacity - the combination has low potential for any agricultural use.

PPA 37-2 has soils similar to those of PPA 37-1, but these occupy the hilly areas northeast of and adjacent to the Ghab depression. The limiting factors of the soils, especially lack of moisture capacity, are emphasized on the steeper slopes. Agricultural potential is very low in this PPA.

These PPAs are characterized by an average annual precipitation range of 400-600 mm, with somewhat lower precipitation in the eastern parts of the PPAs. The mean annual temperature range is 15-16^{o}C. During the wet season (Nov. through Mar.) average monthly precipitation is 82-86 mm and the monthly temperature ranges from 7 to 11^{o}C. Climatic differences are not agriculturally significant due to the limiting nature of the soils in both PPAs.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Only fruit trees and pistachios are reported as crops in this RPU.

A partial flora list for the RPU follows:

Cupressus sempervirens
Styrax officinalis
Laurus nobilis
Arbutus andrachne
Phillyrea media
Cistus villosus
Spartium junceum
Cytisus villosa
Ruscus aculeatus
Cotinus coggygria
Lonicera etrusca
Pistacia palaestina
Erica verticillata
Astragalus spinosus
Thymus syriacus
Noaea mucronata
Hordeum bulbosum
Dactylis hispanica
Bromus danthoniae
Cousinia spp.
Centaurea spp.
Carthamus spp.
Anchusa spp.
Alkanna spp.
Phlomis spp.
Onoperdon anisacanthum

Asparagus aphyllus
Jasminum fruticans
Osyris alba
Ephedra campylopoda
Phlomis longifolia
Dryopteris australis
Origanum syriacus (marus)
Smilax aspera
Quercus aegilops
Quercus infectoria
Ceratonia siliqua
Myrtus communis
Pollinia distachya
Cephalaria joppica
Salvia spp.
Phalaris spp.
Silene coniflora
Echinops blanchaenus
Hypericum triquetrifolium
Euphorbia spp.
Stipa bromoides
Orchideae
Quercus calliprinos
Sarcopoterium spinosum
Nerium oleander
Hyparrhenia hirta
Urginea maritima
Clematis flammula

WATER RESOURCES AND USES:

No reservoirs are in the area. The northern portion, which drains south to the Orontes, contains five springs with total average annual flows of 26 l/sec. Four other springs are along the east edge of the Ghab Valley and total flows are 720 l/sec.

The Roudj Irrigation Network (3,150 hectares) west of Idleb is in this RPU. The three large springs situated on the eastern edge of this network provide the water for irrigation.

The Water Basin Administration study has four test wells in this RPU. They averaged 224 m in depth and two of them showed 2 m static and 39 m dynamic water level with an average yield of 6.5 m^3/hr. A few crops are irrigated from the network, springs or wells, and 20,000 hectares of nonirrigated crops are raised in Ariha Mantika, which is partially in this RPU.

CROP RECOMMENDATIONS:

RPU 37 consists of two PPAs which might be expected to differ in suitability for various specialty crops, but there is little potential in either for the production of cultivated major crops.

PPA PROPERTIES	37-1	37-2
GENERAL		
elevation	300-640 m	300-940 m
dominant range of slope	10-15%	15-30%
portion of RPU	35%	65%
CLIMATE		
- Annual Characteristics		
average precipitation	400-600 mm# (497-515 mm)	400-600 mm# (497-515 mm)
average temperature	15-17°C#	15-17°C#
- Wet Season Characteristics		
average monthly precipitation	> 60 mm@ (82-86 mm)	> 60 mm@ (82-86 mm)
average monthly temperature	7-11°C+	8-11°C+
period of wet season	November through March	November through March
SOILS		
principal components	Lithic Xerorthents, vertic phase	Lithic Xerorthents, vertic phase
depth to bedrock	30-50cm	30-50cm
texture	moderately fine	moderately fine
coarse fragments	stony	stony
permeability	moderate	moderate
reaction	moderately alkaline	moderately alkaline
salinity	nonsaline	nonsaline
available water capacity	low	low
drainage class	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	low	very low
susceptibility to erosion	moderate	severe
most intensive land use	pasture	pasture-woodland

RPU 38

GENERAL DESCRIPTION:

RPU 38 is comprised of three areas mostly underlain by basalt from which deep heavy-textured soils have formed on undulating plains. The largest of the areas extends 75 kilometers northward from the vicinity of Hama with elevations ranging from 280 to 500 m and local relief of 20 to 40 m. Another area lies about 12 kilometers to the southwest of Hama where elevations range from near 370 to 440 meters with local relief of less than 40 m. The third area is in northeastern Syria west of Al-Hasakeh; it extends about 40 kilometers to the northwest on undulating and rolling plains with elevations ranging from 330 to 430 meters. Together these segments of the RPU cover an area of approximately 258,400 hectares. The mean annual temperature range is 17^{o} to 19^{o}C. Annual precipitation ranges from 400 mm to 1,000 mm.

RPU 38 is divided into three PPAs, based on climatic differences. The soils are relatively uniform as is the topography.

PRODUCTION POTENTIAL AREAS:

PPA 38-1 is located in the southern part of the easternmost region of RPU 38 (near Al-Hasakeh). This PPA has a somewhat lower average annual precipitation than the other PPAs. During the wet season (Nov. through April) the monthly precipitation averages are more than 38 mm.

PPA 38-2 includes the southwestern part of the largest section of RPU 38, the southern purlieu in the west, and the northern half of the eastern part of RPU 38 near Al-Hasakeh. During the wet season (Nov. through April) the average monthly precipitation is less than 60 mm.

PPA 38-3 encompasses a large part of the largest purlieu of RPU 38. During the wet season (Nov. through April) the average monthly precipitation is more than 60 mm. The climate along the eastern boundary of the PPA is somewhat dryer than the more western regions. However, this fringe area is too small and insignificant to be treated as a separate PPA.

Soils of the PPAs are Typic Chromoxererts, deep nonstony soils limited in the availability of soil moisture by the heavy clay texture of the soil. Permeability of these soils is slow, a factor that makes irrigation farming more difficult to manage. Although some characteristics are inhibiting, the moderately high fertility and gently sloping topography favor use of the PPA for cropland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Reported crops for this area include wheat, watermelon, muskmelon, pistachio, grapes, figs, and olives.

The reported vegetation includes the plants listed below:

Astragalus spinosa
Thymus syriacus
Noaea mucronata
Hordeum bulbosum
Dactylis hispanica

Quercus aegilops
Quercus calliprinos
Quercus infectoria
Sarcopoterium spinosum
Ceratonia siliqua

Bromus danthoniae
Cousinia spp.
Centaurea spp.
Carthamus spp.
Anchusa spp.
Alkanna spp.
Phlomis spp.
Onoperdon anisacanthum
Phalaris spp.
Echinops blanchaenus
Euphorbia spp.
Styrax officinalis
Arbutus andrachne
Cistus villosus
Cytisus villosus
Cotinus coggygria
Pistacia palaestina
Asparagus aphyllus
Osyris alba
Phlomis longifolia
Origanum syriacus (marus)
Smilax aspera
Nerium oleander
Myrtus communis
Hypparhenia hirta
Pollinia distachya
Urginea maritima
Cephalaria joppica
Clematis flammula
Salvia spp.
Silene coniflora
Hypericum triquetrifolium
Cupressus sempervirens
Laurus nobilis
Phillyrea media
Spartium junceum
Ruscus aculeatus
Lonicera etrusca
Erica verticillata
Jasminum fruticans
Ephedra campylopoda
Dryopteris australis
Stipa bromoides
Orchidaceae

WATER RESOURCES AND USES:

Two reservoirs for domestic use northeast of Hama show a capacity of 651,000 m^3 with no storage reported in 1978. No springs are reported. In the Aleppo Basin there are four government test wells and three Water Basin Administration wells. The four wells average 289 m deep, 305 m static water level, 132 m dynamic level, and 8.1 m^3/hr yield. The WBA wells average 232 m, 34 m, 41 m, and 10.2 m^3/hr, respectively.

There are no reservoirs southwest of Hama. Four government test wells are in this area. They average 170 m deep, 72 m static level, 78 m dynamic level, and 21.9 m^3/hr yield.

The area in Hydro Subbasin 1 is situated northwest of Al-Hasakeh. It has one reservoir with a capacity of 1,900,000 m^3. The water is used for irrigation; it filled in 1978. Two government test wells are located in this part of the RPU. They average 326 m deep and one well shows a static level of 1 m, a dynamic level of 9 m, and a yield of 58.1 m^3/hr. The Upper Khabour Irrigation Network is partly in this area. The gauging station at Tell Tamen showed an annual flow of 1,633.6 million m^3. This water comes largely from a spring upstream near the head of the Khabour River, though there are no springs in this RPU. Irrigated crops reportedly total only 4,000 hectares.

CROP RECOMMENDATIONS:

For irrigated crops, all the PPAs in RPU 38 may be rated high in potential for small grains, olives, grapes, vegetables, and nonrosaceous fruit (nut) trees. Without irrigation oil crops and nonrosaceous fruit trees may be said to have medium potential in PPAs 38-2 and 38-3.

PPA PROPERTIES	38-1	38-2	38-3
GENERAL			
elevation	280-500 m	280-500 m	280-500 m
dominant range of slope	3-8%	3-8%	3-8%
portion of RPU	25%	25%	50%
CLIMATE			
- Annual Characteristics			
average precipitation	400-1,000 mm#	400-1,000 mm#	400-1,000 mm#
average temperature	17-19°C#	17-19°C#	17-19°C#
- Wet Season Characteristics			
average monthly precipitation	> 38 mm@	< 60 mm@ (51 mm)	> 60 mm@
average monthly temperature	8-9°C+	9-12°C+	9-12°C+
period of wet season	November through April	November through April	November through April
SOILS			
principal components	Typic Chromoxererts	Typic Chromoxererts	Typic Chromoxererts
depth to bedrock	more than 1.5 m	more than 1.5 m	more than 1.5 m
texture	fine	fine	fine
coarse fragments	nonstony	nonstony	nonstony
permeability	slow	slow	slow
reaction	mildly alkaline	mildly alkaline	mildly alkaline
salinity	nonsaline	nonsaline	nonsaline
available water capacity	low	low	low
drainage class	moderately well drained	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderately high	moderately high	moderately high
susceptibility to erosion	moderate	moderate	moderate
most intensive land use	cropland	cropland	cropland

RPU 39

GENERAL DESCRIPTION:

RPU 39 occupies a single broad area consisting of level and undulating plains not far to the southwest of Al-Rakka. Of the nearly 246,800 hectares in this RPU, about 60 percent are soils that are shallow to a layer of cemented calcium carbonate. Another 35 percent are gypsiferous soils with seriously limiting characteristics for agricultural use. Elevations range from 300-420 m and local relief from a few to 25 m.

The RPU has been divided into two coarsely patterned PPAs on the basis of potential for agriculture.

PRODUCTION POTENTIAL AREAS:

PPA 39-1 comprises most of the RPU although it includes two quite different soils. In somewhat more than the western half of the RPU, Typic Paleorthid soils, on undulating plains, predominate. They have moderately fine to medium textures and stony surfaces. They are shallow to a rocklike layer of indurated calcium carbonate. They are moderately alkaline and slightly saline and have low water holding capacity. Although they are moderately well drained and have high base saturation and moderate permeability, their shallow depth would seriously impede the maintenance of proper moisture relationships if used as cropland under a program of irrigation. In the eastern third of the RPU, the dominant soils are Typic Gypsiorthids, also on undulating plains. Included are small areas of Petrogypsic Gypsiorthids which have a cemented gypsum horizon at shallow depth. The gypsiferous soils have low levels of productivity. The combination of the shallow Typic Paleorthids and the highly gypsiferous Typic Gypsiorthids mark this PPA as one with little potential for agricultural use. Measures to overcome some of the limitations, assuming availability of irrigation water, are too expensive with present-day technology to consider a more intensive land use than that of rangeland.

PPA 39-2 is a relatively small PPA made up of areas created by desert outwash. The soils in these level flint-strewn, but generally nonstony areas are Typic Torriorthents - well drained, rapidly permeable, coarse-textured soils with moderate to low available moisture capacities. The PPA would be suited for use as cropland if water for irrigation were available, but careful management would be required to prevent a build-up of salinity.

The climate in the RPU is uniform with winters that are typically cool and rainy while the summers are warm and dry. The mean annual temperature range is 17^{o} to 19^{o}C. Annual precipitation ranges from 150 mm to 200 mm. During the wet season (Oct. through May) the average monthly precipitation is less than 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Barley and wheat are reported as crops in this RPU.

The regional flora includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Helianthemum sessiliflorum
Heliotropium persicum
Onobrychis spp.
Salsola spinosa

Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Erodium pulverulentum
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Carex spp.
Scabiosa olivieri
Cousinia weshonii
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Astragalus duplostrigosus
Scleropoa dichotoma
Silene coniflora
Salsola vermiculata
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Scabiosa aucheri
Poa spp.

WATER RESOURCES AND USES:

About 25,000 hectares in RPU 39 are estimated to be suitable for irrigation. Some irrigation now occurs, but the extent and location are not clear and water supplies are meagre. No reservoirs or springs are reported and there are only a few wells. This RPU contains the Risafe Unit of the Euphrates project. Water will be available with development of the project. One government test well is in this area. The depth is 501 m; other information is not available.

CROP RECOMMENDATIONS:

The climate of RPU 39 is so uniformly dry that rainfed agriculture is rarely if ever feasible. PPA 39-1 consists of soils whose potential would not be significantly increased by irrigation. With irrigation, PPA 39-2 has high potential for some nonrosaceous fruit trees, as well as some vegetables, and medium for small grains (especially barley), cotton, tuber/root crops, olives, and pulses.

PPA PROPERTIES	39-1	39-2
GENERAL		
elevation	300-420 m	320-400 m
dominant range of slope	3-8%	0-3%
portion of RPU	90%	10%
CLIMATE		
- Annual Characteristics		
average precipitation	150-200 mm#	150-200 mm#
average temperature	17-19^{o}C#	17-19^{o}C#
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@	< 38 mm@
average monthly temperature	13-14^{o}C^{+}	13-14^{o}C^{+}
period of wet season	October through May	October through May
SOILS		
principal components	Typic Paleorthids Typic Gypsiorthids	Typic Torriorthents
depth to bedrock	10-25 cm (petrocalcic horizon)	50-100 cm
texture	coarse - moderately coarse	coarse
coarse fragments	stony; nonstony	nonstony
permeability	moderate	rapid
reaction	moderately alkaline	moderately alkaline
salinity	slightly saline	moderately saline
available water capacity	low; very low	very low
drainage class	moderately well drained	somewhat excessively drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	very low	low
susceptibility to erosion	low; subsidence on Gypsiorthids	slight
most intensive land use	rangeland	cropland (irrigated)

RPU 40

GENERAL DESCRIPTION:

RPU 40 consists of alluvial plains and adjacent level plains of north central Syria in the upper reaches of the Euphrates and Balikh River valleys and undulating plains south of Al-Hasakeh near the Khabour River. Soils of the valley floors are deep alluvium; those of the adjacent higher lands are formed from unconsolidated materials. The RPU totals about 291,100 hectares excluding the area of the Euphrates Reservoir. Elevations range from 260 m to 360 m. The mean annual temperature range is 17^{o} to 20^{o}C. Annual precipitation ranges from 200 mm to 350 mm.

The RPU is divided into four coarsely patterned PPAs on the basis of differences in soils and topographic position and precipitation differences.

PRODUCTION POTENTIAL AREAS:

PPA 40-1 includes the combined areas of the valley floors of both the Euphrates and the Balikh Rivers, about 19 percent of the RPU. The soils, Xeric Torrifluvents, are like those of PPA 32-1. In these northern valleys of the Euphrates system, however, some additional benefit for agriculture would be derived from the somewhat higher rainfall than received in the PPA 32-1 desert areas. The climate is characterized by annual precipitation of 200-300 mm. During the wet season (Nov. through May) the average monthly precipitation is less than 38 mm.

PPA 40-2 consists of four areas, one east of Jarablus, another in the northern Balikh Valley, one southwest of the Euphrates Reservoir, and one in the Khabour Valley. Soils of the western three areas of this PPA are coarse-textured, rapidly permeable and have very low available water capacity. They are slightly to moderately alkaline and saline. The soils in the Euphrates Valley are moist during the winter months and are Xeric Torriorthents; those in the Balikh valley are dry much of the year and are Typic Torriorthents.

The soils of the Khabour River area, also Typic Torriorthents, are not so coarse-textured as those near the Euphrates Reservoir. Their topography is more undulating; they are only slightly alkaline and saline, are moderately permeable and have better moisture holding capacity. Productive potential of the soils in the PPA is moderate to moderately high. With the addition of soil amendments to improve fertility, they would be suitable for use as irrigated cropland under good management.

The climate for PPA 40-2 is characterized by an annual precipitation of 200-300 mm. During the wet season (Nov. through May) the average monthly precipitation is less than 38 mm.

PPAs 40-3 and 40-4 both have annual precipitation ranges from 250-350 mm. During the wet season (Nov. through May) the average monthly precipitation is less than 60 mm.

The soils correspond to PPAs 40-1 and 40-2 respectively, and are described under these corresponding PPAs.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Cotton, vegetables (most are irrigated), grain, and poplars are raised as crops in RPU 40.

A partial flora is included for this RPU below:

Helianthemum sessiliflorum
Heliotropium persicum
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshoni
Artemisia scoparia
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Astragalus duplostrigosus
Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Silene coniflora
Salsola vermiculata
Peganum harmala
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Cousinia spp.
Teucrium polium
Stipa lagaceae
Scleropoa dichotoma
Cousinia chaborasica
Linum balansae
Centaurea balsamitoides
Carthamus oxyacantha
Olivieria orientalis
Convolvulus reticulatus
Achillea oligocephala
Onobrychis lanata
Phlomis bruguieri
Aegilops spp.
Hordeum sp.
Plantago notata
Erodium pulverulentum
Poa sinaica
Astragalus tribuloides
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus

WATER RESOURCES AND USES:

No reservoirs other than Lake Al-Assad, with a capacity near 12 billion m^3, are situated in this RPU. No springs or government test wells are reported. The Balikh River has an annual flow of arund 190 million m^3. Irrigated agriculture is practiced along the respective rivers from pumps. Most of the soils are suitable for irrigated crop production.

The western area includes a portion of the Meskeneh Unit and the central area a portion of the Balikh Unit of the Euphrates reclamation project. Water would come from the Lake Al-Assad storage. Studies have been made of two storage reservoirs on the Upper Khabour, with capacities of 600 million m^3 and 320 million m^3, which could irrigate most of the Khabour area of this RPU. This area is also identified, at least in part, as Irrigation Network 3 - 60,000 hectares.

CROP RECOMMENDATIONS:

With irrigation PPAs 40-1, 40-3 and 40-4 have high potential for small grains and medium potential for pulses, rosaceous fruit trees, tuber/bulb crops and vegetables. PPA 40-2 has high potential for small grains, oil crops, cotton and vegetables; medium potential for fruit trees and pulses.

Without irrigation, all PPAs in RPU 40 lack significant agricultural potential.

PPA PROPERTIES	40-1	40-2	40-3	40-4
GENERAL				
elevation	260-360 m	280-360 m	260-360 m	280-360 m
dominant range of slope	0-3%	0-8%	0-3%	0-8%
portion of RPU	19%	31%	19%	31%
CLIMATE				
- Annual Characteristics				
average precipitation	200-300 mm# (200-234 mm)	200-300 mm# (200-234 mm)	250-350 mm# (301-333 mm)	250-350 mm# (301-333 mm)
average temperature	17-20°C# (18°C)	27-30°C# (18°C)	17-19°C# (17.2-17.5°C)	17-19°C# (17.2-17.5°C)
- Wet Season Characteristics				
average monthly precipitation	< 38 mm@ (26-32 mm)	< 38 mm@ (26-32 mm)	< 60 mm@ (41-45 mm)	< 60 mm@ (41-45 mm)
average monthly temperature	13-14°C+	13-14°C+	12-13°C+	12-13°C+
period of wet season	November through May	November through May	November through May	November through May
SOILS				
principal components	Xeric Torrifluvents	Typic and Xeric Torriorthents	Xeric Torrifluvents	Typic and Xeric Torriorthents
depth to bedrock	greater than 5 m	greater than 1 m	greater than 5 m	greater than 5 m/ greater than 1 m
texture	fine	coarse/medium	fine	coarse/medium
coarse fragments	nonstony	nonstony/stony	nonstony	nonstony/stony
permeability	moderately slow	moderately rapid to rapid/moderate	moderately slow	moderately rapid to rapid/moderate
reaction	moderately alkaline	mildly to moderately alkaline/ mildly alkaline	moderately alkaline	mildly to moderately alkaline/ mildly alkaline

Continued

PPA PROPERTIES	40-1	40-2	40-3	40-4
SOILS (con't)				
salinity	slight to moderate	slight to moderate/slight	slight to moderate	slight to moderate/slight
available water capacity	moderate	very low/moderate	moderate	very low/moderate
drainage class	moderately well	somewhat excessively drained/ moderately well drained	somewhat well drained	somewhat excessively drained/ moderately well drained
INTERPRETATIONS FOR AGRICULTURE				
inherent productive capacity	moderate	moderate	moderate	moderate
susceptibility to erosion	slight	slight	slight	slight
most intensive land use	cropland, if irrigated	cropland, if irrigated	cropland, if irrigated	cropland, if irrigated

RPU 41

GENERAL DESCRIPTION:

RPU 41 consists of two areas of rolling plains underlain by basalt, one about 10 kilometers south-southeast of Aleppo, the other, northeast of Al-Hasakeh. They comprise an area of nearly 114,400 hectares. Elevations range from 400-500 m and local relief near 100 m. The mean annual temperature range is 17° to 19°C. Annual precipitation ranges from 200 mm to 300 mm.

The RPU comprises three coarsely to finely patterned PPAs, the more extensive characterized by soils with little or no agricultural potential and the other having potential but being difficult to manage.

PRODUCTION POTENTIAL AREAS:

PPA 41-1 consists of the gently sloping parts of the RPU; it represents approximately 80 percent of the RPU. The soils are Lithic Xerorthents, which are very shallow to the underlying basalt; in many places there is no soil and the bedrock is exposed. Because of the severe limitations imposed by shallowness, the soils have little potential except for use as rangeland for the browse afforded by the native vegetation. The climatic areas of this PPA are not agriculturally significant when associated with soils of limited potential.

During the wet season (Dec. through April) the average monthly precipitation ranges from 29-45 mm.

PPA 41-2 consists of deeper soils occurring in a coarse to fine pattern of distribution among those of PPA 41-1. They are Typic Chromoxererts, moderately deep and deep fine-textured soils in flat areas and depressions distributed among the gently sloping knolls. These are mostly well drained alkaline soils with some surficial stoniness. They are slowly permeable and available moisture capacity is low. Potentially, these are productive soils suited for use as cropland where stoniness is not severe. Irrigation would be needed to assure optimum yields. During the wet season (Dec. through April) the average monthly precipitation is greater than 38 mm.

PPA 41-3 consists of the same soils (Typic Chromoxererts) as described under PPA 41-2. During the wet season (Dec. through April) monthly precipitation averages are less than 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

The following crops were observed or reported in this RPU: corn, figs, wheat, cotton, and eucalyptus.

Vegetation reported for the RPU includes:

Lactuca orientalis
Astragalus spp.
Anchusa strigosa
Achillea santolina
Gypsophila rokejeka
Carthamus flavescens
Onosma aleppica

Centaurea damascena
Noaea mucronata
Alkanna strigosa
Eryngium desertorum
Stachys nivea
Althaea rufescens
Phlomis damascena

Bromus danthoniae
Salvia spp.
Stipa sp.
Cousinia aleppica
Trigonella sp.

WATER RESOURCES AND USES:

Although about a fifth of the soils are suitable for irrigated crop production, no reservoirs or springs are reported in this RPU and there appears to be no surface water. The area southeast of Aleppo contains one government test well. This well is 141 m deep with 9 m static water level, 61 m dynamic level, and 15.2 m^3/hr yield. This area also includes a portion of the Meskeneh Unit of the Euphrates Project which is due to receive water from Lake Al-Assad. A small part of the area northeast and adjacent to Al-Hasakeh is irrigated, and additional land in this RPU is in the 60,000 hectares of Irrigation Network 2 - Upper Khabour. Both irrigated and nonirrigated crops are found in the mantika covered by part of RPU 41.

CROP RECOMMENDATIONS:

PPA 41-1 has no significant potential for conventional major crops, due to soil conditions.

PPA 41-2 and 41-3 have medium potential for the production of small grains with irrigation. Where the intensity of the wet season is slightly greater, yield differentials can be expected.

PPA PROPERTIES	41-1	41-2	41-3
GENERAL			
elevation	400-500 m	400-500 m	400-500 m
dominant range of slope	3-15%	0-3%	0-3%
portion of RPU	80%	10%	10%
CLIMATE			
- Annual Characteristics			
average precipitation	200-300 mm# (222-272 mm)	200-300 mm# (272 mm)	200-300 mm# (222 mm)
average temperature	17-19^{o}C#	17-19^{o}C#	17-19^{o}C# 18.3^{o}C
- Wet Season Characteristics			
average monthly precipitation	< to > 38mm@ (29-45 mm)	> 38 mm@ (45 mm)	< 38 mm@ (29 mm)
average monthly temperature	9-11^{o}C^{+}	9-11^{o}C^{+}	9-11^{o}C^{+}
period of wet season	December through April	December through April	December through April
SOILS			
principal components	Lithic Xerorthents,	Typic Chromoxererts	Typic Chromoxererts
depth to bedrock	less than 50 cm	greater than 50 cm	greater than 50 cm
texture	medium to coarse	fine	fine
coarse fragments	stony	stony	stony
permeability	moderate to rapid	slow	slow
reaction	alkaline	alkaline	alkaline
salinity	-	-	-
available water capacity	low	low	low
drainage class	well drained	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	low	moderate to high	moderate to high
susceptibility to erosion	moderate	low	low
most intensive land use	rangeland	cropland, irrigated	cropland, irrigated

RPU 42

GENERAL DESCRIPTION:

RPU 42 covers an area of 91,200 hectares on undulating plains near Al-Rakka adjacent to the Euphrates River valley. It consists of broad areas of deep gypsiferous soils overlying weakly consolidated materials separated by a narrow band of alluvial soils along the Balikh River just east of Al-Rakka; a few scattered rocky plains and prominences and saline playas relieve the uniformity of the landscape. Elevations range from 260-400 m with local relief of 5-40 m.

Two coarsely patterned PPAs make up the RPU. By far the more extensive consists of the upland plains; the other is the narrow band of alluvium along the Balikh River.

PRODUCTION POTENTIAL AREAS:

Both PPAs have the same climate characterized by an annual precipitation of 150-250 mm, and average annual temperature between 18 and 19^{o}C. During the wet season (Oct. through May) the average monthly precipitation is less than 38 mm.

PPA 42-1 consists of two areas of Calcic Gypsiorthids, one on either side of the Balikh River, together about 95% of the RPU. They are deep sandy loams of moderate permeability, mild alkalinity, and low available water capacity and moderately well drained. Content of gypsum (calcium sulfate) is high. The depths at which gypsic layers occur affect variously the productivity and also water-related problems of such soils. In general the Calcic Gypsiorthids would be productive if nitrogen and phosphate fertilizers were used to overcome deficiencies in the supply of nitrogen and the unavailability of the phosphorous. Problems with these soils, however, are also physical. Sloping gypsiferous soils are very erosive because of the lack of cohesiveness. Gypsum is also very soluble, a characteristic that leads readily to subsidence, particularly if gypsiferous soils are irrigated or even crossed by seeping irrigation canals and ditches. Where irrigation is practiced, levelling of the land both before irrigation and annually thereafter is necessary to avoid formation and subsequent enlargement of poorly draining subsidence depressions. These can lead also to "piping," a process wherein the soil becomes channeled beneath the surface, thus carrying away and wasting irrigation water and further increasing the possibility of subsidence.

If the limiting characteristics of the Calcic Gypsiorthids, both chemical and physical, can be managed well and assuming availability of irrigation water this PPA could be moderately productive.

PPA 42-2 is the remaining 5% of the RPU, but has greater potential for agricultural use. The soils are Xeric Torrifluvents - deep, fine-textured, well to moderately well drained, moderately slowly permeable soils. They are alkaline and slightly saline. These are productive soils suited for use as cropland. Irrigation is necessary for optimum yields but careful management is necessary to prevent build-up of toxic levels of salinity.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Irrigated cotton is raised in this RPU.

A list of some of the vegetation occurring in this RPU is below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Scabiosa aucheri
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Trigonela radiata
Helianthemum aegyptiacum
Cousinia chaborasica
Linum balansae
Centaurea balsamitoides
Carthamus oxyacantha
Oliveria orientalis
Convolvulus reticulatus
Achillea oligocephala
Onobrychis lanata
Phlomis bruguieri
Aegilops spp.
Hordeum spp.
Plantago notata
Helianthemum sessiliflorum
Heliotropium persicum
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshonii
Artemisia scoparia
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Astragalus duplostrigosus
Scleropoa dichotoma
Cousinia spp.
Teucrium polium
Stipa lagaceae
Stipa spp.
Hypecoum pendulum

WATER RESOURCES AND USES:

RPU 42 includes part or all of the Euphrates Project pilot and experimental area, which is now largely irrigated by pumping. The soils are all classed as suitable for crop production under irrigation. No small reservoirs or springs are reported for this RPU. One government test well is in the area; depth 225 m but other information is not available. This RPU is part of the Balikh Unit of the Euphrates Reclamation Project which is scheduled to receive irrigation water from Lake Al-Assad.

CROP RECOMMENDATIONS:

RPU 42 is consistently too dry for rainfed production of conventional major crops. The soils of PPA 42-1 would require such extensive modification before they could be used for irrigated agriculture that it would not be useful to predict, in advance of soil modifications, crops which might be suited for them. PPA 42-2 has high potential for small grains, and medium potential for pulses, rosaceous fruit trees, tuber/bulb crops, and vegetables.

PPA PROPERTIES	42-1	42-2
GENERAL		
elevation	260-400 m	260-300 m
dominant range of slope	5-8%	0-3%
portion of RPU	95%	5%
CLIMATE		
- Annual Characteristics		
average precipitation	150-250 mm#	150-250 mm#
average temperature	18-19°C#	18-19°C#
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@	< 38 mm@
average monthly temperature	13-15°C+	13-15°C+
period of wet season	October through May	October through May
SOILS		
principal components	Calcic Gypsiorthids	Xeric Torrifluvents
depth to bedrock	greater than 1.5 m	greater than 1.5 m
texture	moderately coarse	fine
coarse fragments	nonstony	nonstony
permeability	moderate	moderately slow
reaction	mildly alkaline	alkaline
salinity	nonsaline	saline
available water capacity	low	moderate
drainage class	moderately well drained	well and moderately well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate	moderate to high
susceptibility to erosion	moderate to severe	low
most intensive land use	cropland, irrigated	cropland, irrigated

RPU 45

GENERAL DESCRIPTION:

RPU 45 includes two areas of gypsiferous soils in northeastern Syria, one on undulating plains southeast of Al-Hasakeh, the other to the southwest on level plains. Their total area is approximately 139,500 hectares, varying in elevation from 300-400 m.

The RPU consists of one PPA (PPA 45-1) because the climatic and soil characteristics are generally uniform.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 18° to 20°C. Annual precipitation ranges from 150 mm to 250 mm. During the wet season (Nov. through April) the average monthly precipitation is less than 38 mm.

PPA 45-1, except for minor inclusions of other gypsiferous soils, consists of Calcic Gypsiorthids on level and undulating plains. The soils are like those discussed for PPA 42-1. Potential for economic use is severely limited by the high content of gypsum. However, as in RPU 42, if both chemical and physical limitations are offset by intensive management, and water for irrigation could be made available, the PPA would be moderately production for adapted crops.

REPORTED OR OBSERVED CROPS AND VEGETATION:

This RPU was not visited; however, our information sources suggested that only barley is grown.

Vegetation reported for RPU 45 is listed below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus

Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Spergularia diandra
Helianthemum sessiliflorum
Heliotropium persicum
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshoni
Artemisia scoparia
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Astragalus duplostrigosus
Scleropoa dichotoma
Scabiosa aucheri

WATER RESOURCES AND USES:

Precipitation in RPU 45 is low - less than 250 mm annually. While soils are generally classed as suitable for irrigation, no reservoirs or springs are reported, both areas of the RPU seem to be outside either the Euphrates Project or the middle-Khabour proposed project, and prospects for both appear to be negligible. One government test well is located in the eastern area. It is 100 m deep and has a static level of 9 m, a dynamic level of 25 m, and a yield of 24.0 m^3/hr.

CROP RECOMMENDATIONS:

While immense technological investment in RPU 45 might make farming possible, speculation about crop performance is inadvisable.

PPA PROPERTIES	45-1
GENERAL	
elevation	300-400 m
dominant range of slope	0-8%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	150-250 mm#
average temperature	18-20°C#
- Wet Season Characteristics	
average monthly precipitation	< 38 mm@
average monthly temperature	11-12°C+
period of wet season	November through April
SOILS	
principal components	Calcic Gypsiorthids
depth to bedrock	more than 1.5 m
texture	moderately coarse
coarse fragments	nonstony
permeability	moderate
reaction	mildly alkaline
salinity	nonsaline
available water capacity	low
drainage class	moderately well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low-moderate
susceptibility to erosion	moderate to severe (subsidence and erosion)
most intensive land use	cropland (if irrigated); otherwise rangeland

RPU 46

GENERAL DESCRIPTION:

RPU 46 is an extensive area of nearly 1,021,000 hectares of undulating to rolling plains and gypsiferous soils that stretches eastward from the Balikh River and beyond Al-Hasakeh to the border, interrupted midway by the Jebel Abdul Aziz. Elevations range mainly from 340-500 m with isolated higher points. The mean annual temperature range is 18^{o} to 20^{o}. Annual precipitation ranges from 150 mm to 300 mm.

The RPU consists of three coarsely patterned PPAs distinguished by differences in both soils and climate.

PRODUCTION POTENTIAL AREAS:

PPA 46-1 covers most of the RPU except a broad area in the southwest between the Balikh River and the western margins of the Abdul Aziz and scattered areas to the east lying between the Abdul Aziz and the eastern border. Like the other gypsiferous soils, the Petrogypsic soils are coarse textured, but unlike them, they are shallow to a strongly cemented layer and are stony. Their poor water holding capacity and low available fertility in a water deficient region makes them of low potential for agricultural improvement. They are best used as rangeland.

During the wet season (Dec. through May) the average monthly precipitation ranges from 25-38 mm.

PPA 46-2 includes the large area of Typic Gypsiorthids to the south and west of the Jebel Abdul Aziz and similar areas between the Jebel and the eastern border, with a few relatively smaller areas of Calcic Gypsiorthids. The large area in the west, on rolling plains has not only the same problems of poor soil-moisture relationships, subsidence hazards, and low available fertility that characterize the gypsiferous soils in general, but also the probability of severe erosion losses. The less sloping areas in the east are somewhat less endangered by erosion. This PPA has low to moderate potential for agricultural use but if managed carefully under irrigation could be productive for adapted crops. During the wet season (Dec. through May) the average monthly precipitation is primarily less than 38 mm.

Like PPA 46-2, PPA 46-3 includes the large area of Typic Gypsiorthids to the south and west of the Jebel Abdul Aziz and similar areas between the Jebel and the eastern border, with a few relatively smaller areas of Calcic Gypsiorthids. The large area in the west, on rolling plains has not only the same problems of poor soil-moisture relationships, subsidence hazards, and low available fertility that characterize the gypsiferous soils in general, but also the probability of severe erosion losses. The less sloping areas in the east are somewhat less endangered by erosion. This PPA has low to moderate potential for agricultural use but if managed carefully under irrigation could be productive for adapted crops. During the wet season (Dec. through May) the average monthly precipitation is usually above 38 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Three crops were seen or reported in RPU 46: cotton, grain, and cabbage.

A non-exhaustive flora list is below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Salsola inermis
Senecio desfontainei
Plantago notata
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Spergularia diandra
Helianthemum sessliflorum
Heliotropium persicum
Onobrychis spp.
Salsola spinosa
Scabiosa olivieri
Cousinia weshonii
Artemisia scoparia
Haloxylon salicornicum
Erodium glaucophyllum
Achillea conferta
Aristida plumosa
Astragalus duplostrigosus
Scleropoa dichotoma
Scabiosa aucheri

WATER RESOURCES AND USES:

Although about a third of the soils of RPU 46 are suitable for irrigated crop production, there appears to be no evident source of water. The area is outside Euphrates Project lands and evidently is not in any portion of Khabour River proposed developments. One reservoir - 440,000 m^3 - is located south of Al-Hasakeh and west of the Khabor River. It listed no storaged in 1978. There are no springs in this RPU.

There are 17 government test wells in the RPU with some concentration east of Al-Hasakeh. The average depth of these wells is 180 m with a static level of 20 m, dynamic level of 41 m, and 26.1 m^3/hr yield. Most wells are in sand formation but other wells are in anhydrite or marls formations; gravels occur with the sand formation.

CROP RECOMMENDATIONS:

PPA 46-1 lacks agricultural potential for the production of conventional major crops. However, the PPAs 46-2 and 46-3 have medium potential for small grains and cotton under irrigation.

PPA PROPERTIES	46-1	46-2	46-3
GENERAL			
elevation	370-500 m	340-450 m	340-450 m
dominant range of slope	8-15%	3-8%	3-8%
portion of RPU	70%	15%	15%
CLIMATE			
- Annual Characteristics			
average precipitation	150-300 mm# (186-291 mm)	150-300 mm# (186-291 mm)	200-300 mm#
average temperature	18-20°C# (19.1°C)	18-20°C# (19.1°C)	18-20°C#
- Wet Season Characteristics			
average monthly precipitation	25 mm > 38 mm@	25 mm > 38 mm@	> 38 mm@
average monthly temperature	11-13°C+	12-13°C+	11-13°C+
period of wet season	December through May	December through May	December through May
SOILS			
principal components	Petrogypsic Gypsiorthids	Typic Gypsiorthids Calcic Gypsiorthids	Typic Gypsiorthids Calcic Gypsiorthids
depth to bedrock	25-50 cm (cemented layer)	greater than 1 m	greater than 1 m
texture	moderately coarse	moderately coarse	moderately coarse
coarse fragments	stony	nonstony	nonstony
permeability	moderate	moderate	moderate
reaction	neutral	neutral	neutral
salinity	slightly saline	slightly saline	slightly saline
available water capacity	low	very low	very low
drainage class	moderately well	moderately well	moderately well
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	low	low-moderate	low-moderate
susceptibility to erosion	severe	moderate to severe (subsistence)	moderate to severe (subsistence)
most intensive land use	rangeland	cropland (if irrigated) otherwise rangeland	cropland (if irrigated) otherwise rangeland

RPU 47

GENERAL DESCRIPTION:

RPU 47 lies in the far northwestern part of Syria and consists of the valley of the Afrin River and its tributary valleys. This area of about 48,700 hectares is mostly level although the stream itself is somewhat entrenched in the northern part so that there are steep slopes near the river. Elevations range from less than 200 m in the south to more than 400 m near the northern border with Turkey.

The RPU has one PPA (47-1); both the climate and soils are homogeneous.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 16^{o} to 19^{o}C. Annual precipitation ranges from 400 mm to 600 mm. During the wet season (Nov. through Mar.) the average monthly precipitation ranges from 73 to 85 mm.

The soils are mainly Typic Chromoxererts, identical with those of PPA 25-2 in the adjacent RPU. They are deep well drained, fine-textured soils that become very hard and crack when dry and are sticky and plastic when wet. They are slowly permeable and have low available moisture capacities. Inherently, they are productive soils suited for use as cropland but would be difficult to manage.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Crops reported or observed were olives, pomegranates, figs, citrus, grapes, watermelon, cotton, grain, cauliflower, potatoes, eggplant, onions, sunflowers, and chickpeas. Figs, grapes or chickpeas intercropped with olives were noted.

A list of vegetation observed or reported follows:

Celtis tournefortii
Loranthus europaeus
Melia azedarach
Morus sp.
Quercus infectoria
Avena pratensis
Sambucus ebulus
Geranium libanoticum
Pelargonium sp.
Fraxinus spp.
Verbascum sp.
Cupressus sp.
Pinus sp.
Quercus calliprinos
Lathyrus cassius
Pteris aquilina
Festuca laevis
Papaver sp.

WATER RESOURCES AND USES:

One of two gauging stations on the Afrin River included in the study is reported in RPU 36. The lower station near Afrin shows an annual average flow of about 146 million m^3, an amount which could irrigate about 2,000 hectares. Stream flow is very low during July-December, which creates a seasonal distribution problem.

No reservoirs or government test wells were reported in this RPU. Ten springs with an average annual total flow of 2,361 l/sec are shown. This valley is largely in Irrigation Network 11 and is comprised of 15,000 hectares (1974). A study of a reservoir and irrigation development to be located near Medante has been completed. The proposed development would store 230 million m^3 and irrigate 20,000 hectares of land.

CROP RECOMMENDATIONS:

RPU 47 (consisting of PPA 47-1) is a relatively productive area with varied agricultural possibilities. Without irrigation, it has high potential for small grains, olives, cotton, grapes, and some pulses, and medium potential for oil crops. If irrigation is provided, the area would have high potential for all the crops mentioned above, as well as nonrosaceous fruit trees.

PPA PROPERTIES	47-1
GENERAL	
elevation	200-400 m
dominant range of slope	0-3%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	400-600 mm# (508-517 mm)
average temperature	16-19°C# (18°C)
- Wet Season Characteristics	
average monthly precipitation	< 90 mm@ (73 to 85 mm)
average monthly temperature	8-11°C+
period of wet season	November through March
SOILS	
principal components	Typic Chromoxererts
depth to bedrock	1.5-2.0 m
texture	fine
coarse fragments	stony
permeability	slow
reaction	mildly alkaline
salinity	-
available water capacity	moderate
drainage class	moderately well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	moderate to high
susceptibility to erosion	low
most intensive land use	cropland

RPU 48

GENERAL DESCRIPTION:

RPU 48 is an extensive unit on level and undulating limestone plains lying to the east and northeast of the Euphrates Reservoir and a second area mainly on level plains west and northwest of the reservoir. Elevation ranges from 290 to 520 m. Together they are an area of 398,200 hectares.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 17^{o} to 19^{o}C. Annual precipitation ranges from 200 mm to 300 mm. During the wet season (Nov. through April) the average monthly precipitation is generally less than 38 mm. Toward the western part of the RPU there is a transition to a climate with average monthly precipitation exceeding 38 mm.

In PPA 48-1, the principal soils, Lithic Xerorthents, vertic phase, and Typic Paleorthids are both shallow to a thick undurated layer of calcium carbonate of rocklike hardness (petrocalcic layer). The soils are generally stony but textures are mainly clayey. They are moderately well drained but moderate to moderately slow in permeability and of low available water capacity. Although the soils of this PPA are inherently moderately fertile, their potential is severely limited by physical characteristics that can be altered, e.g., ripping of the petrocalcic layer, only with great expense and difficulty if at all. In their natural condition the soils are suited for use as pasture land and rangeland; if the petrocalcic layer is ripped, the soils could be used to produce specialized crops under irrigation.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Several crops were reported, or observed, in RPU 48. These were barley, pistachio, fruit trees, figs, grapes, pomegranates, corn, cotton, poplars, vegetables, grapes intercropped with cherries, and irrigated grain.

The vegetation includes:

Cousinia chaborasica
Linum balansae
Centaurea balsamitoides
Carthamus oxyacantha
Convolvulus reticulatus
Achillea oligocephala
Onobrychis lanata
Phlomis bruguieri
Aegilops spp.
Alkanna hirsutissima
Anchusa mesopotamica
Delphinium glandulosum
Elymus delileanus
Oliveria orientalis
Althaea lasiecalycina
Achillea santolina
Leguminosae
Cousinia spp.
Teucrium polium

Anchusa leptocephala
Phlomis kurdica
Eryngium vulgare
Oliveria orientalis
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Phlomis bruguieri
Carex spp.
Poa spp.
Scabiosa aucheri
Leontodon hispidulus
Verbascum cestroides
Achillea spp.

Stipa legaeceae
Artemisia herba-alba
Achillea fragrantissima
Noaea mucronata
Carex stenophylla
Adonis dentata
Salsola inermis
Plantago notata
Erodium pulverulentum
Poa sinaica
Astragalus tribuloides
Anthemis deserti-syriaci
Malcomia torulosa
Centaurea behen
Haloxylon articulatum
Astragalus spp.
Ephedra alata
Centaurea laxa
Spergularia diandra
Senecio desfontainei
Silene coniflora
Salsola vermiculata
Peganum harmala
Salvia lanigera
Arnebia decumbens
Schismus arabicus

WATER RESOURCES AND USES:

One reservoir north of Al-Rakka has a capacity of 620,000 m^3. It is listed for domestic use, possibly in Al-Rakka. Storage was at 70 percent capacity in 1978. Portions of this RPU are in units included in the Euphrates Project. Part of the Meskeneh Unit is in the west and part of the Balikh Unit is in the east, northwest of Al-Rakka. No springs are shown in this area. Two government test wells - one in the east near Al-Rakka and one in the west - are included in the study. They average 75 m in depth with one well (east area) showing static level at 14 m, dynamic level at 40 m, and a yield of 40.0 m^3/hr. Some 5,000 hectares of irrigated crops are reportedly produced.

CROP RECOMMENDATIONS:

In PPA 48-1, if the heavy technological investment of breaking the petrocalcic layer is made, these soils, with irrigation, would have high potential for producing small grains, fruit trees (rosaceous and nonrosaceous), oil crops, vegetables, and medium potential for grapes and cotton. Without irrigation, the soils would have medium potential for small grains or oil crops.

PPA PROPERTIES	48-1
GENERAL	
elevation	290-520 m
dominant range of slope	0-8%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	200-300 mm# (244-299 mm)
average temperature	17-19°C# (16.8°C)
- Wet Season Characteristics	
average monthly precipitation	< to > 38 mm@ (28 to 43 mm)
average monthly temperature	9-11°C+
period of wet season	November through April
SOILS	
principal components	Lithic Xerorthents, vertic phase, Typic Calciorthids
depth to bedrock	10-25 cm
texture	medium to moderately fine
coarse fragments	stony
permeability	moderate to moderately slow
reaction	moderately alkaline
salinity	slightly saline
available water capacity	low to moderate
drainage class	moderately well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low
susceptibility to erosion	slight
most intensive land use	cropland (hay, forage)

RPU 49

GENERAL DESCRIPTION:

RPU 49, an area of about 87,100 hectares on level and undulating plains extends 80 kilometers southeastward from the northern border east of Jarablus. Elevation ranges from 350-600 m. Soils are predominantly shallow and stony.

Because of the similarities of the climates and a single class of soils that vary mainly in slope, only one PPA (PPA 49-1) is identified.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 17^{o} to 19^{o}C. Annual precipitation ranges from 250 mm to 350 mm. During the wet season (Nov. through May) the average monthly precipitation is less than 60 mm.

PPA 49-1 soils consist primarily of Lithic Xerorthents, vertic phase. They are on level topography in the eastern two thirds of the RPU, and on more undulating plains westward. These soils are clayey, stony, somewhat slowly permeable, and shallow to bedrock or a rocklike layer of calcium carbonate.

This PPA has a low potential for agricultural use because of low available moisture capacity, shallowness to impervious layers, and difficulty in tilling the fine textured soil. It is best suited for use as pastureland or rangeland. Where the underlying material is a relatively thin layer of calcium carbonate, deep chisel plowing could be used to break up the impervious layer, thus opening the soils for better soil moisture relationships, increasing the rooting depth, and enhancing their potential for production of selected crops.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Barley has been reported for this RPU, which was not visited.

Vegetation in this RPU includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Cousinia charborasica
Linum balansae
Centaurea balsamitoides
Carthamus oxycantha
Oliveria orientalis
Convolvulus reticulatus
Achillea oligocephala
Onobrychis lanata
Phlomis bruguieri
Aegilops spp.
Hordeum spp.
Alkanna hirsutissima
Anchusa mesopotamica
Delphinium glandulosum
Elymus delileanus
Phlomis bruguieri
Oliviera orientalis
Althaea lasiecalycina

Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Achillea santolina
Cousinia chaborasica
Leguminosae
Verbascum cestroides
Achillea spp.
Centaurea behen
Scabiosa aucheri

WATER RESOURCES AND USES:

Although no reservoirs, springs, or government test wells are shown in this study, RPU 49 at least borders if not includes a portion of the Balikh Unit of the Euphrates Project. About 12,000 hectares of intensive agriculture are reported, primarily in cotton and winter wheat.

CROP RECOMMENDATIONS:

RPU 49 (PPA 49-1) is not well suited to rainfed agriculture. If irrigation is provided, the area has medium potential for the production of small grains in those areas where it is economically feasible to break up the impervious subsoil layers.

PPA PROPERTIES	49-1
GENERAL	
elevation	350-600 m
dominant range of slope	0-8%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	250-350 mm#
average temperature	17-19°C#
- Wet Season Characteristics	
average monthly precipitation	< 60 mm@
average monthly temperature	8-10°C+
period of wet season	November through May
SOILS	
principal components	Lithic Xerorthents-vertic phase
depth to bedrock	30-50 m
texture	moderately fine
coarse fragments	stony
permeability	moderately slow
reaction	moderately alkaline
salinity	moderately saline
available water capacity	low
drainage class	moderately well drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	low
susceptibility to erosion	slight to moderate
most intensive land use	pastureland, rangeland, cropland if hard surface layer can be shattered.

RPU 50

GENERAL DESCRIPTION:

In RPU 50, the principal area is a broad rolling plain that parallels the northern border of Syria from the Balikh River valley on the west, continuing 60 kilometers beyond the valley of the Khabour River on the east. The level plain of the Khabour reaching southeastward to Al-Hasakeh, and an undulating area north of the town make up a less extensive part of the RPU. Elevations along the Khabour range from 300-350 m and in the border area from 350-420 m with an estimated area of 193,500 hectares. The mean annual temperature range is 17° to 19°C. Annual precipitation ranges from 250 mm to 400 mm.

Three coarsely patterned PPAs were delineated on the basis of climate, soil differences, and topography.

PRODUCTION POTENTIAL AREAS:

PPA 50-1 comprises the rolling plains along the northern border, plus the undulating area north of the town of Al-Hasakeh. Dominant soils of these areas are Xeric Torriorthents, soils that are transitional between those of the desert and the somewhat better watered soils of a Mediterranean climate. They are well drained, medium textured, and moderately to rapidly permeable; the soils are well supplied with bases and are alkaline. Available moisture capacity is low because of the shallow depth of soil over the coarse stony substratum. Surficial stoniness is common. Although the soils are similar to those of PPA 23-1, they are somewhat lower in potential for farming because of more rolling topography which diminishes moisture retention and increases the hazard of erosion. The PPA is best suited for use as pastureland; however, with a high level of management and water for irrigation it could be made suitable for use as cropland.

During the wet season (Oct. through May) the average monthly precipitation is less than 38 mm in the south and increases to more than 38 mm but less than 60 mm in the north.

PPA 50-2 includes the valley floor and terraces of the Khabour River with Typic Xerochrepts as the principal soils. Although parent materials are gravelly and surfaces are stony, these soils have moderate water-holding capacity and permeability and good depth. Under good management this PPA should have at least a moderate potential for agricultural use if adequate water supplies are available. The climate is characterized by an annual precipitation of less than 300 mm. During the wet season (Oct. through May) the average monthly precipitation is less than 38 mm, but toward the north the average monthly precipitation exceeds 38 mm.

PPA 50-3, has soils similar to, and described under, PPA 50-2. The area is situated in the northern part of the RPU where the climate is wetter than that in PPA 50-2. During the wet season (Nov. through May) the average monthly precipitation ranges from 40-51 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Wheat, corn, figs, cotton (irrigated) and eucalyptus are raised in RPU 50.

A partial flora list for the RPU includes:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaura laxa
Adonis dentata
Salsola inermis
Plantago notata
Erodium pulverulentum
Poa sinaica
Astragalus tribuloides
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus
Cousinia chaborasica
Linum balansae
Centaurea balsamitoides
Carthamus oxyacantha
Oliveria orientalis
Convolvulus reticulatus
Achillea oligocephala
Onobrychis lanata
Phlomis bruguieri
Aegilops spp.
Cousinia spp.
Stipa lagaceae
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Spergularia diandra
Senecio desfontainei
Silene coniflora
Salsola vermiculata
Peganum harmala
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Alkanna hirsutissima
Anchusa mesoptamica
Delphinium glandulosum
Elymus delileanus
Phlomis bruguieri
Oliviera orientalis
Althaea lasiecalycina
Achillea santolina
Leguminosae
Hordeum spp.
Teucrium polium

WATER RESOURCES AND USES:

The eastern portion of the RPU around Al-Hasakeh is partly irrigated and is included in Irrigation Network 2 - Upper Khabour. A canal (gravity) from the Khabour River is listed with Network 2. An area of 4,542 hectares is served by this canal, though the precise location of the canal and irrigated lands is not clear. No reservoirs or springs are shown in this RPU. Seven government test wells in this study are scattered throughout the RPU. These wells average 163 m in depth, with static level at 30 m, dynamic level at 44 m, and average yield at 64.9 m^3/hr, the largest yield for wells in the study. Four wells are in limestone formation, two in marls, and one in sand.

About 25,000 hectares reportedly are irrigated. Most of the irrigated land is used for wheat and cotton production. Sheep and goat production is also important here.

CROP RECOMMENDATIONS:

RPU 50 has a relatively homogeneous dry climate which is sufficiently wet only in PPA 50-3 to have medium potential for rainfed small grains. PPAs 50-2 and 50-3, under irrigation and appropriate management, would have medium potential for small grains, olives, grapes, fruit trees, vegetables and oil crops. PPA 50-1, under irrigation, would have medium potential for small grains and some vegetables.

PPA PROPERTIES	50-1	50-2	50-3
GENERAL			
elevation	350-420 m	300-350 m	300-350 m
dominant range of slope	3-15%	0-3%	0-3%
portion of RPU	74%	18%	8%
CLIMATE			
- Annual Characteristics			
average precipitation	250-400 mm# (279-374 mm)	250-400 mm# (280 mm)	300-400 mm# (300-374 mm)
average temperature	17-19^{o}C# (17.8-18.3^{o}C)	17-19^{o}C#	17-19^{o}C#
- Wet Season Characteristics			
average monthly precipitation	< 60 mm@ (35-51 mm)	< 38 mm to > 38 mm@	< 60 @mm (40-51 mm)
average monthly temperature	12-14^{o}C^{+}	11-14^{o}C^{+}	11-13^{o}C^{+}
period of wet season	October through May	October through May	November through May
SOILS			
principal components	Xeric Torriorthents	Typic Xerochrepts	Typic Xerochrepts
depth to bedrock	greater than 50 cm	greater than 1 m	greater than 1 m
texture	medium	medium	medium
coarse fragments	stony	stony	stony
permeability	moderate	moderate	moderate
reaction	mildly alkaline	mildly alkaline	mildly alkaline
salinity	-	slightly saline	slightly saline
available water capacity	moderate	moderate	moderate
drainage class	well drained	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate	moderate to moderately high	moderate to moderately high
susceptibility to erosion	moderate-severe	slight	slight
most intensive land use	pasture, irrigated cropland	irrigated cropland	cropland

RPU 51

GENERAL DESCRIPTION:

RPU 51 is essentially the rugged crests and dissected footslopes of the upland area known as the Jebel Abdul Aziz that lies to the southwest of Al-Hasakeh in northeastern Syria. The area of RPU 51 is estimated to be 223,800 hectares and elevations range from 400-1000 m. The mean annual temperature range is 16° to 19°C. Annual precipitation ranges from 250 mm to 350 mm.

The RPU is divided into three coarsely patterned PPAs on the basis of soils and climate.

PRODUCTION POTENTIAL AREAS:

PPA 51-1 consists of the rough rocky slopes of the Jebel Abdul Aziz. Primary soils are Lithic Camborthids, soils that are of medium texture, moderate permeability, non-saline and slightly alkaline. Their water holding capacity is low, however, and they are very shallow, steeply sloping, and stony. Potential for agricultural use is very low; the area is suited for use as rangeland for the poor browse it affords.

During the wet season (Nov. through April) the average monthly precipitation is less than 60 mm.

PPA 51-2 comprises two areas of deeper soils, Xeric Torriorthents, at lower elevations adjacent to the Jebel Abdul Aziz on the northeast and southeast. They are stony, medium-textured, moderately to rapidly permeable soils with low available moisture holding capacity. The PPA is best suited for use as rangeland; however, if water for irrigation were available the less stony areas would be suited for use as cropland. During the wet season (Nov. through April) the average monthly precipitation is less than 38 mm.

PPA 51-3 soils are described under the description for PPA 51-2. During the wet season (Nov. through April) the average monthly precipitation is less than 60 mm.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Wheat and cotton were observed in this RPU.

The vegetation of RPU 51 is listed, in part, below:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Spergularia diandra
Pistacia atlantica
Pistacia khinjuk
Crataegus azarolus
Amygdalus orientalis

Erodium pulverulentum
Salsola vermiculata
Stipa barbata
Cousinia chaborasica
Salvia lanigera
Anthemis deserti-syriaci
Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Scabiosa aucheri
Prunus tortuosa
Poa sinaica
Peganum harmala
Astragalus tribuloides
Phragmites communis
Typha latifolia
Scirpus tuberosus
Cyperus longus
Ranunculus aquatilis
Nuphar luteum
Eleocharis palustris

WATER RESOURCES AND USES:

The soils are generally poor although about a third of the RPU could be used for irrigated crops. However, there is no evidence of a potential water supply. No reservoirs, springs, or government test wells are shown for this RPU. It is outside the boundaries of the Euphrates Project and the proposed Khabour Project.

CROP RECOMMENDATIONS:

Jebel Abdul Aziz is, as its name implies, a mountainous upland, and it has a dry climate. Agricultural potential for conventional crops is limited. PPA 51-1 offers little opportunity for soil improvement. PPAs 51-2 and 51-3 have deeper soils and would have medium potential for fruit trees or small grains if irrigated and managed properly. PPA 51-3 would have slightly greater potential than 51-2 for some specialty crops if irrigation were not provided.

PPA PROPERTIES	51-1	51-2	51-3
GENERAL			
elevation	600-1000 m	400-450 m	400-450 m
dominant range of slope	8-35%	3-15%	3-15%
portion of RPU	70%	20%	10%
CLIMATE			
- Annual Characteristics			
average precipitation	250-350 mm#	250-350 mm#	250-350 mm#
average temperature	16-19°C#	16-19°C#	16-19°C#
- Wet Season Characteristics			
average monthly precipitation	< 60 mm@	< 38 mm@	< 60 mm@
average monthly temperature	8-11°C+	7-10°C+	10-11°C+
period of wet season	November through April	November through April	November through April
SOILS			
principal components	Lithic Camborthids	Xeric Torriorthents	Xeric Torriorthents
depth to bedrock	30-50 cm	greater than 50 cm	greater than 50 cm
texture	medium	medium	medium
coarse fragments	stony	stony	stony
permeability	moderate	moderate	moderate
reaction	mildly alkaline	mildly alkaline	mildly alkaline
salinity	-	-	-
available water capacity	low	moderate	moderate
drainage class	well drained	well drained	well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	very low	moderate	moderate
susceptibility to erosion	severe	moderate-severe	moderate-severe
most intensive land use	rangeland	range, cropland (irrigated)	range, cropland (irrigated)

RPU 52

GENERAL DESCRIPTION:

RPU 52 comprises four discontiguous areas of rolling plains in northeast Syria, southwest and southeast of Al-Kamishli. Total area is approximately 462,500 hectares. Elevation ranges from 400 to 520 m. The mean annual temperature range is 17° to 19°C. Annual precipitation ranges from 300 mm to 500 mm.

RPU 52 is subdivided into three coarsely-patterned PPAs on the basis of climate. The soils and topography (discussed in PPA 52-3) are generally uniform.

PRODUCTION POTENTIAL AREAS:

PPA 52-1 is located in the southern part of the largest (western) area of the RPU. (It contains Al-Kamishli and extensive land which is east, west, and south of the town.)

The climate is characterized by an annual precipitation of 300-400 mm. During the wet season (Nov. through May) the monthly precipitation averages are usually above 38 mm.

PPA 52-2 accounts for the central part of the largest (western) area, the eastern two areas and the western area. The climate has an annual precipitation ranges from 300-500 mm. During the wet season (Nov. through May) the average monthly precipitation ranges between 38 mm and 60 mm.

PPA 52-3 encompasses the northern part of the largest (western) area. The climate is generally like that of PPA 52-2 but with higher rainfall during the months of the wet season, usually greater than 60 mm per month.

The soils of PPAs 52-1, 52-2, and 52-3 are primarily Vertic Xerochrepts and associated Xeric Torriorthents, both on rolling plains. These soils are of medium to moderately fine texture, moderately deep, moderate in permeability and available water capacity, and are moderately well drained. The Xeric Torriorthents are also stony and in some places shallow to bedrock. Inherent fertility of these soils is moderate to good, but they are susceptible to erosion because of the rolling topography. They are productive soils and under good management are well suited for use as cropland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Wheat, forage, cotton, sugarbeets, carrots, oats, and cabbage, are raised in this RPU.

Vegetation reported or observed:

Phlomis bruguieri
Achillea spp.
Anchusa leptocephala
Eryngium vulgare
Oliviera orientalis
Althaea lasiecalycina
Achillea santolina
Cousinia chaborasica
Verbascum cestroides
Centaurea behen
Phlomis kurdica
Alkanna hirsutissima
Anchusa mesoptamica
Delphinium glandulosum
Elymus delileanus

WATER RESOURCES AND USES

Gauging station 13 has been labelled as being in the small western area of this RPU. This location is essentially the headwaters of the Khabour River and the flow is largely from a spring. The average annual flow at this station is about 1,370 million m^3. This area is also within the boundaries of Irrigation Network 2 - Upper Khabour.

The western area also includes the Jaghjagh River, a tributary to the Khabour. Annual flow of this river is around 125 million m^3. Two reservoirs are under construction in the central area of the RPU on smaller tributaries of the Khabour. Both reservoirs will be for irrigation - the Jarrah with a capacity of 19.5 million m^3 and the Maachouq with a capacity of 1.7 million m^3. No springs are shown in this area. There is information on 25 government test wells which are generally scattered over the three main areas of the RPU. They average 132 m in depth, static level at 34 m, dynamic level at 50 m, and yield at 26.4 m^3/hr. The wells are mostly in limestone or sand formations.

CROP RECOMMENDATIONS:

Potential of RPU 52 for irrigated crops is generally the same for all PPAs: high for oil crops, small grains, cotton, vegetables, and tuber/bulb crops; under nonirrigated conditions, PPA 52-1 would have little potential for any crop group except barley, whereas PPAs 52-2 and 52-3 would have medium potential for small grains.

PPA PROPERTIES	52-1	52-2	52-3
GENERAL			
elevation	400-520 m	400-520 m	400-520 m
dominant range of slope	8-15%	8-15%	8-15%
portion of RPU	10%	60%	30%
CLIMATE			
- Annual Characteristics			
average precipitation	300-400 mm#	300-500 mm# (331-432 mm)	400-500 mm# (471-480 mm)
average temperature	17-19°C#	17-19°C# (17.9°C)	17-19°C# (18.9°C)
- Wet Season Characteristics			
average monthly precipitation	> 38 mm@	> 38 to < 60 mm@ (56-59 mm)	> 60 mm@ (65--71 mm)
average monthly temperature	11-12°C+	11-12°C+	11-13°C+
period of wet season	November through May	November through May	November through May
SOILS			
principal components	Vertic Xerochrepts/ Xeric Torriorthents	Vertic Xerochrepts/ Xeric Torriorthents	Vertic Xerochrepts/ Xeric Torriorthents
depth to bedrock	50-110 cm	50-110 cm	50-110 cm
texture	medium to moderately fine	medium to moderately fine	medium to moderately fine
coarse fragments	nonstony/stony	nonstony/stony	nonstony/stony
permeability	moderate	moderate	moderate
reaction	mildly alkaline	mildly alkaline	mildly alkaline
salinity	nonsaline	nonsaline	nonsaline
available water capacity	moderate	moderate	moderate
drainage class	moderately well drained	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE			
inherent productive capacity	moderate to high	moderate to high	moderate to high
susceptibility to erosion	moderate to severe	moderate to severe	moderate to severe
most intensive land use	cropland, pasture	cropland, pasture	cropland, pasture

RPU 53

GENERAL DESCRIPTION:

RPU 53 in northeastern Syria is a shallow level basin of about 140,700 hectares formed by the drainage of several wadis. Elevations range from 340 to 380 m. The mean annual temperature range is 18^{o} to 19^{o}C. Annual precipitation ranges from 250 mm to 400 mm.

RPU 53 has been divided into two coarsely patterned PPAs because of climatic differences.

PRODUCTION POTENTIAL AREAS:

PPA 53-1 is in the northern part of RPU 53. Annual precipitation ranges from 300-400 mm. During the wet season (Nov. through May) the average monthly precipitation is less than 60 mm.

PPA 53-2 comprises the southern portion of the RPU. Its climate is characterized by an annual precipitation that is less than 300 mm. During the wet season (Nov. through May) the monthly precipitation averages are usually less than 60 mm.

Soils in PPAs 53-1 and 53-2 are deep, somewhat dark-colored Aeric Haplaquepts formed in a deep accumulation of colluvium over marl and limestone. Soil textures are clayey but permeability and available water capacity are moderate, and these soils are moderately well to somewhat poorly drained. Although slightly alkaline, they are either nonsaline or only slightly so. Management of these soils should include very careful water management, to include both drainage and irrigation. Potentially they are productive soils suited for use as cropland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Only wheat has been reported for this RPU.

A partial list of reported vegetation follows:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Astragalus spp.
Ephedra alata
Centaurea laxa
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Selene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Peganum harmala
Astragalus tribuloides
Salvia lanigera
Anthemis deserti-syriaci
Cousinia spp.
Teucrium polium
Stipa lagaceae
Noaea mucronata
Carex stenophylla
Adonis dentata
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Alkanna hirsutissima
Anchusa mesoptamica
Delphinium glandulosum
Elymus delileanus

Arnebia decumbens
Malcomia torulosa
Schismus arabicus
Leontodon hispidulus
Scabiosa aucheri
Cousinia chaborasica
Centaurea balsamitoides
Carthamus oxyacantha
Achillea oligocephala
Phlomis bruguieri
Phlomis bruguieri
Oliviera orientalis
Althaea lasiecalycina
Hordeum spp.
Leguminosae
Linum balansae
Aegilops spp.
Convolvulus reticulatus
Onobrychis lanata

WATER RESOURCES AND USES:

This RPU is east of Al-Hasakeh and extends to the border. The soils are potentially productive for irrigated crops, but water potentials are small and LANDSAT shows no intensive agricultural land. No reservoirs or springs are reported. The study includes 10 government test wells distributed over the area. Average depth of the wells is 158 m, with static level at 11 m, dynamic level at 25 m, and yield of 20 m^3/hr. The wells are about equally divided between limestone, marls, and sand formations.

CROP RECOMMENDATIONS:

For irrigated crops, the two PPAs in RPU 53 have essentially identical potentials: medium for fruit trees (rosaceous), oil crops, olives, and small grains. Without irrigation, these may still be medium potential in PPA 53-1 for oil crops and small grains. Almost all the crop groups rated prefer good drainage and this would have to be the subject of careful management.

PPA PROPERTIES	53-1	53-2
GENERAL		
elevation	340-380 m	340-380 m
dominant range of slope	less than 3%	less than 3%
portion of RPU	50%	50%
CLIMATE		
- Annual Characteristics		
average precipitation	300-400 mm# (385 mm)	250-400 mm# (287 mm)
average temperature	18-19°C#	18-19°C#
- Wet Season Characteristics		
average monthly precipitation	< 60 mm@ (53 mm)	< 60 mm@ (40 mm)
average monthly temperature	11-12°C+	11-13°C+
period of wet season	November through May	November through May
SOILS		
principal components	Aeric Haplaquepts	Aeric Haplaquepts
depth to bedrock	more than 1.5m	more than 1.5m
texture	moderately fine	moderately fine
coarse fragments	nonstony	nonstony
permeability	moderate	moderate
reaction	mildly alkaline	alkaline
salinity	non- or slightly-saline	non- or slightly-saline
available water capacity	moderate	moderate
drainage class	moderately well drained to somewhat poorly drained	moderately well drained to somewhat poorly drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	high	high
susceptibility to erosion	slight	slight
most intensive land use	cropland	cropland

RPU 54

GENERAL DESCRIPTION:

RPU 54, an area of rolling topography in northeasternmost Syria east of Al-Kamishli, covers approximately 156,100 hectares. It is an area of deep, fine-textured soils formed from basalt. Elevations range from 400-650 m. The mean annual temperature range is 17° to 19°C. Annual precipitation ranges from 350 mm to 500 mm.

The RPU is divided into two coarsely patterned PPAs on the basis of climatic differences.

PRODUCTION POTENTIAL AREAS:

PPA 54-1 is located in the southern portion of the RPU. During the wet season (November through May) the average monthly precipitation is less than 60 mm.

PPA 54-2 comprises the northern region of the RPU. The characteristic precipitation and temperature ranges are similar to that in the south but during the wet season (Nov. through May) the monthly precipitation averages more than 60 mm.

PPAs 54-1 and 54-2 consist of Typic Chromoxererts, deep, nonstony fine-textured soils with low rates of permeability and low available water content. They are difficult to manage, being hard and cracked when dry and becoming sticky and plastic when wet. They are productive soils well suited for use as cropland but would require very careful management, including erosion controls, to produce optimum yields.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Wheat is raised in RPU 54. No other crops have been reported.

Vegetation reported or observed:

Alkanna hirsutissima
Anchusa mesoptamica
Delphinium glandulosum
Elymus delileanus
Phlomis bruguieri
Oliviera orientalis
Althaea lasiecalycina
Achillea santolina
Cousinia chaborasica
Linum pubescens
Verbascum cestroides
Achillea spp.
Centaurea behen
Anchusa leptocephala
Phlomis kurdica
Eryngium vulgare
Cymbopogon laniger
Quercus spp.
Olea europea
Ficus carica
Morus alba
Vitis vinifera
Psoralea jaubertiana
Centaurea sclerolepis
Asphodelus microcarpus
Trifolium spp.
Hedysarum pogonocarpum
Onobrychis spp.
Echium spp.
Chrysopogon gryllus
Cynara syriaca
Verbascum auriculatum
Triticum aegilopoides
Onopordon spp.

WATER RESOURCES AND USES:

Water for supplemental irrigation would be productive, but water development prospects are not evident. Two small reservoirs for irrigation are centrally situated in this RPU. The capacity of one reservoir, Jouadieh, is 8 million m^3; it filled in 1978. The other reservoir, Bab Al-Hadid, capacity of 23 million m^3, was 90 percent filled in 1978. Irrigation Network 16 - Bab Al-Hadid (3,000 hectares), is served by two canals, one each out of the reservoirs noted above. The Bab Al-Hadid canal is designed to irrigated 2,248 hectares and Jouadieh canal serves 75 hectares but the extent of development is not known.

No springs are shown in this RPU. Six government test wells are included in the study. They average 126 m in depth, 13 m static water level, 46 m dynamic level, and 17.1 m^3/hr yield. Basalt formation is most frequent among these wells but others are limestone and sand.

CROP RECOMMENDATIONS:

For irrigated crops, PPA 54-1 may be rated high in potential for small grains, olives, grapes, vegetables, and nonrosaceous fruit (nut) trees. Without irrigation, PPA 54-1 and 54-2 would be rated with medium potential for oil crops and nonrosaceous fruit trees.

PPA PROPERTIES	54-1	54-2
GENERAL		
elevation	400-650 m	400-650 m
dominant range of slope	8-15%	8-15%
portion of RPU	50%	50%
CLIMATE		
- Annual Characteristics		
average precipitation	350-500 mm# (401 mm)	350-500 mm# (473 mm)
average temperature	17-19^{o}C#	17-19^{o}C#
- Wet Season Characteristics		
average monthly precipitation	< 60 mm@ (54 mm)	> 60 mm@ (65 mm)
average monthly temperature	11-12C^{+}	11-12^{o}C^{+}
period of wet season	November through May	November through May
SOILS		
principal components	Typic Chromoxererts	Typic Chromoxererts
depth to bedrock	greater than 1.5 m	greater than 1.5 m
texture	fine	fine
coarse fragments	nonstony	nonstony
permeability	slow	slow
reaction	mildly alkaline	mildly alkaline
salinity	nonsaline	nonsaline
available water capacity	low	low
drainage class	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate	moderate
susceptibility to erosion	moderate-severe	moderate-severe
most intensive land use	cropland, pasture	cropland, pasture

RPU 55

GENERAL DESCRIPTION:

RPU 55 is a relatively small area of 31,100 hectares of shallow stony soils formed from basalt on rolling plains in northeastern Syria. Elevations range from 475 to 700 meters.

One PPA is identified.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 18° to 20°C. Annual precipitation ranges from 400 mm to 500 mm. During the wet season (Nov. through May) the monthly precipitation averages about 67 mm.

The soils are Lithic Xerorthents, too shallow and stony for use other than as pastureland and rangeland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

In this RPU only barley was reported.

Vegetation for the RPU includes the plants listed below:

Quercus spp.
Ficus carica
Vitis vinifera
Centaurea sclerolepis
Trifolium spp.
Onobrychis spp.
Chrysopogon gryllus
Verbascum auriculatum
Cymbopogon laniger
Linum pubescens
Olea europaea
Morus alba
Psoralea jaubertiana
Asphodelus microcarpus
Hedysarum pogonocarpum
Echium spp.
Cynara syriaca
Triticum aegilopoides
Onopordon spp.

WATER RESOURCES AND USES:

It appears that a tributary of the Tigris River constitutes the north boundary of the area. A planned reservoir, Saffan, on this tributary is shown on the map but it was not on the current list supplied for this study. No reservoirs or springs are reported for this RPU. One government test well is in the study sample. It is 200 m deep with static level at 20 m, dynamic level at 25 m, and 24.0 m^3/hr yield. It is in an anhydrite-limestone formation. LANDSAT shows no intensively cultivated areas.

CROP RECOMMENDATIONS:

RPU 55 (PPA 55-1) is not suited to conventional major crop production because of the nature of the soils.

PPA PROPERTIES	55-1
GENERAL	
elevation	475-700 m
dominant range of slope	8-15%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	400-500 mm# (493 mm)
average temperature	18-20°C# (19.1°C)
- Wet Season Characteristics	
average monthly precipitation	> 60 mm@ (67 mm)
average monthly temperature	11-12°C+
period of wet season	November through May
SOILS	
principal components	Lithic Xerorthents
depth to bedrock	10-25 cm
texture	moderately fine
coarse fragments	rubbly
permeability	moderate
reaction	mildly alkaline
salinity	nonsaline
available water capacity	low
drainage class	somewhat excessively drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	moderate
susceptibility to erosion	moderate-severe
most intensive land use	pastureland, rangeland

RPU 56

GENERAL DESCRIPTION:

RPU 56 lies in the extreme north and east of Syria bounded by the northern border and the Tigris River. It is situated on basalt and has a somewhat subdued rolling landscape. It covers approximately 40,400 hectares. Elevations range from 500 to 600 meters. The mean annual temperature range is 18^{o} to 20^{o}C. Annual precipitation ranges from 500 mm to 800 mm.

Two coarsely patterned PPAs comprise RPU 56, PPA 56-1 in the south and PPA 56-2 in the north. The climates differ and are the basis for the division of the RPU.

PRODUCTION POTENTIAL AREAS:

PPA 56-1's climate has a wet season (Nov. through May) average monthly precipitation of less than 90 mm. PPA 56-2's climate is similar to that of PPA 56-1 except that during the wet season the monthly precipitation averages exceed 90 mm.

The soils in PPAs 56-1 and 56-2 are Typic Chromoxererts, deep, nonstony, fine-textured soils with low available water capacity and low rates of permeability. They are productive soils and have moderate potential for agricultural use. They are difficult to manage because of the high content of clays that alternately shrink and swell as they dry and are re-wet; potential erosion hazard also adds to the difficulty of management. Nonetheless, the soils are productive and suited for use as cropland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Several crops have been reported growing in this RPU. The crops are wheat, cotton, sorghum, and forage. Along the Khabour River, cotton is irrigated.

A partial list of vegetation growing in this RPU is below:

Quercus spp.
Ficus carica
Vitis vinifera
Centaurea sclerolepis
Trifolium spp.
Onobrychis spp.
Chrysopogon gryllus
Verbascum auriculatum
Cymbopogon laniger
Linum pubescens
Olea europa
Morus alba
Psoralea jaubertiana
Asphodelus microcarpus
Hedysarum pogonocarpum
Echium spp.
Cynara syriaca
Triticum aegilopoides
Onopordon spp.

WATER RESOURCES AND USES:

The soils in RPU 56 are suitable for cropland and would be highly productive if irrigated. Reportedly, pumping occurs for irrigation from the Tigris River but details are not available. LANDSAT data show no intensive cultivation. Three reservoirs are planned for irrigation - Al Malkieh (50 million m^3 capacity), Hahmysh (5 million m^3 capacity) and Mansoura (3.5 million m^3 capacity) - on tributaries of the Tigris River. No springs or test wells are shown for this RPU.

CROP RECOMMENDATIONS:

RPU 56 is similar to RPU 54 in agricultural potential, but enjoys the advantage of more rainfall in both PPAs. PPA 56-2 gets slightly more rainfall during the wet season than does PPA 56-1, and this would be expected to influence crop yields but not crop selection. Both PPAs have high potential for small grains and oil crops, and medium potential for pulses, even without irrigation. With irrigation they have high potential for small grains, olives, fruit trees, grapes, cotton, pulses, tuber/bulb crops, and oil crops, and medium potential for vegetables.

PPA PROPERTIES	56-1	56-2
GENERAL		
elevation	500-600 m	500-600 m
dominant range of slope	8-10%	8-10%
portion of RPU	50%	50%
CLIMATE		
- Annual Characteristics		
average precipitation	500-800 mm# (595 mm)	500-800 mm# (657 mm)
average temperature	18-20^{o}C# (18.6-19.1^{o}C)	18-20^{o}C#
- Wet Season Characteristics		
average monthly precipitation	< 90 mm@ (82 mm)	> 90 mm@
average monthly temperature	11-13^{o}C^{+}	11-12^{o}C^{+}
period of wet season	November through May	November through May
SOILS		
principal components	Typic Chromoxererts	Typic Chromoxererts
depth to bedrock	more than 1.5 m	more than 1.5 m
texture	fine	fine
coarse fragments	nonstony	nonstony
permeability	slow	slow
reaction	mildly alkaline	mildly alkaline
salinity	nonsaline	nonsaline
available water capacity	low	low
drainage class	moderately well drained	moderately well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	moderate	moderate
susceptibility to erosion	moderate	moderate
most intensive land use	cropland	cropland

RPU 57

GENERAL DESCRIPTION:

RPU 57 is an extensive area of rolling limestone plains in northern Syria lying to the south of Jarablus on both sides of the Euphrates River valley. Extent of the unit is estimated at 415,600 hectares. Elevations range from 350-660 m. The mean annual temperature is 16^{o} to 18^{o}C. Annual precipitation ranges from 200 mm to 350 mm.

Because of the limited potential of the soils in RPU 57, the RPU was not subdivided into PPAs.

PRODUCTION POTENTIAL AREAS:

The climate of the northern part of the RPU has an average annual precipitation of slightly more than 300 mm. In the southern part of the RPU, the climate is characterized by an average annual precipitation that is less than 300 mm. The wet season (Nov. through May) average monthly precipitation is less than 38 mm.

PPA 57-1 has two co-dominant soils, Lithic Xerorthents, vertic phase, and Lithic Xerochrepts. The Xerochrepts are shallow to limestone bedrock and the Xerorthents are shallow to a thick indurated soil layer of calcium carbonate of rocklike hardness, and both are clayey. Both soils have stony surfaces and low available water capacity. The Xerorthents occupy about 75 percent of the area, the Xerochrepts a wide strip along the eastern border of the RPU. Except for a few small level areas, topography of the entire unit is rolling. Because of erosion hazards, but especially because they are shallow, these soils have very limited potential for agriculture and are best suited for use as pastureland or rangeland.

REPORTED OR OBSERVED CROPS AND VEGETATION:

The only crops reported are pistachio, wheat, and barley.

Reported vegetation includes the following:

Artemisia herba-alba
Haloxylon articulatum
Achillea fragrantissima
Noaea mucronata
Ephedra alata
Carex stenophylla
Centaurea laxa
Adonis dentata
Spergularia diandra
Salsola inermis
Senecio desfontainei
Plantago notata
Silene coniflora
Erodium pulverulentum
Salsola vermiculata
Poa sinaica
Lactuca orientalis
Centaurea damascena
Astragalus spp.
Anchusa strigosa
Alkanna strigosa
Achillea santolina
Eryngium desertorum
Gypsophila rokejeka
Stachys nivea
Carthamus flavescens
Althaea rufescens
Onosma aleppica
Phlomis damascena
Bromus danthoniae
Cousinia aleppica
Salvia spp.

Peganum harmala
Astragalus tribuloides
Salvia lanigera
Arnebia decumbens
Schismus arabicus
Scabiosa aucheri
Anchusa leptocephala
Centaurea balsamitoides
Carthamus oxyacantha
Olivieria orientalis
Achillea oligocephala
Onobrychis lanata
Phlomis bruguieri
Aegilops spp.
Hordeum spp.
Alkanna hirsutissima
Anchusa mesopotamica
Delphinium glandulosum
Elymus delileanus
Carex spp.
Teucrium polium
Verbascum cestroides
Centaurea behen
Stipa lagaceae
Trigonella sp.
Stipa spp.
Anthemis deserti-syriaci
Malcomia torulosa
Leontodon hispidulus
Cousinia chaborasica
Linum balansae
Phlomis kurdica
Eryngium vulgare
Convolvulus reticulatus
Salvia spinosa
Malva aegyptiaca
Evax contracta
Filago spathula
Stipa spp.
Trigonella radiata
Hypecoum pendulum
Helianthemum aegyptiacum
Althaea lasiecalycina
Poa spp.
Leguminosae
Achillea spp.
Cousinia spp.

WATER RESOURCES AND USES:

The Sajour River, which originates in Turkey, passes through RPU 20 and RPU 57 to the Euphrates. Gauging station measurements show the annual flow of the Sajour to be about 88 million m^3. A small reservoir - 2 million m^3 - planned on the Sajour would be used for irrigation. No springs or government test wells are shown. The RPU is upstream from Lake Al-Assad and is not in the Euphrates Irrigation Project.

LANDSAT shows 19,800 hectares of intensive agriculture in this RPU, and there are irrigated crops reported in Ein-Al-Arab and Jarablus Manatik, portions of which are in RPU 57.

CROP RECOMMENDATIONS:

The soils of RPU 57 restrict its agricultural potential severely. Precipitation is sufficient for small grains and certain tree crops. On the basis of present information, the potential, in part, for any of the conventional major crops under consideration is not significant.

PPA PROPERTIES	57-1	
GENERAL		
elevation	350-660 m	
dominant range of slope	8-15%	
portion of RPU	100%	
CLIMATE		
- Annual Characteristics		
average precipitation	200-350 mm# (259-317 mm)	
average temperature	16-18^{o}C# (17.2^{o}C)	
- Wet Season Characteristics		
average monthly precipitation	< 38 mm@ (32-36 mm)	
average monthly temperature	12-14^{o}C^{+}	
period of wet season	November through May	
SOILS		
principal components	Lithic Xerorthents, vertic phase	Lithic Xerochrepts
depth to bedrock	10-25 cm, (petrocalcic layer)	30-50 cm
texture	moderately fine	medium
coarse fragments	stony	stony
permeability	moderately slow	moderate
reaction	moderately alkaline	moderately alkaline
salinity	slightly saline	nonsaline
available water capacity	low	low
drainage class	moderately well drained	well drained
INTERPRETATIONS FOR AGRICULTURE		
inherent productive capacity	low	
susceptibility to erosion	moderately severe	
most intensive land use	pasture and rangeland	

RPU 58

GENERAL DESCRIPTION:

RPU 58 lies about ten kilometers west of Aleppo and covers an area of approximately 44,900 hectares. The area is an extension of the steep, shallow and rocky limestone soils to the north and west. Elevation ranges from 430-800 m.

PPA 58-1 is the only PPA in this RPU.

PRODUCTION POTENTIAL AREAS:

The mean annual temperature range is 17^{o} to 19^{o}C. Annual precipitation ranges from 350 mm to 600 mm. During the wet season (Nov. through April) the monthly precipitation averages more than 60 mm.

The principal soils are Lithic Rhodoxeralfs which are very shallow to the limestone bedrock that outcrops in many places. Steep slopes, shallowness, low available water capacity and excessive drainage combine to limit use of this area to woodland or pastureland; some local moderately and gently sloping areas with slightly deeper soils could be more intensively used for selected crops.

REPORTED OR OBSERVED CROPS AND VEGETATION:

Fruit trees, olives, grain and grapes were observed as crops.

Vegetation reported or observed:

Astragalus spinosa
Noaea mucronata
Dactylis hispanica
Cousinia spp.
Carthamus spp.
Alkanna spp.
Onoperdon anisacanthum
Phalaris spp.
Echinops blanchaenus
Euphorbia spp.
Thymus syriacus
Hordeum bulbosum
Bromus danthoniae
Centaurea spp.
Anchusa spp.
Phlomis spp.
Salvia spp.
Silene coniflora
Hypericum triquetrifolium

WATER RESOURCES AND USES:

No special water development is apparent. No reservoirs, springs, or test wells are shown for this RPU, though there may be scattered tracts of irrigation from wells.

CROP RECOMMENDATIONS:

PPA 58-1 may have, with careful management, medium potential in inextensive areas for nonirrigated olives, small grains, grapes, and certain fruit trees, but appears better suited to woodland.

PPA PROPERTIES	58-1
GENERAL	
elevation	430-800 m
dominant range of slope	15-30%
portion of RPU	100%
CLIMATE	
- Annual Characteristics	
average precipitation	350-600 mm# (414 mm)
average temperature	17-19°C#
- Wet Season Characteristics	
average monthly precipitation	> 60 mm@ (69 mm)
average monthly temperature	9-11°C^{+}
period of wet season	November through April
SOILS	
principal components	Lithic Rhodoxeralfs, bare rock
depth to bedrock	10-50 cm
texture	moderately fine
coarse fragments	very stony
permeability	moderate
reaction	mildly alkaline
salinity	nonsaline
available water capacity	low
drainage class	somewhat excessively drained
INTERPRETATIONS FOR AGRICULTURE	
inherent productive capacity	very low
susceptibility to erosion	severe
most intensive land use	woodland, pasture

C. Land Cover/Use

In order to provide further information on current uses of agricultural land in the various RPUs described above, Landsat imagery was obtained and visually interpreted to produce a land cover/use map for all of Syria. Two separate field trips were made in Syria to verify the interpreted data, and these data were also compared with the statistical data gathered annually by the Ministry of Agriculture and Agrarian Reform.

The visual interpretation of Landsat imagery was based on mutually exclusive categories applicable to Syrian land cover/use patterns. The categories and descriptions were as follows:

Intensive Agriculture -- indicates areas of major irrigation development, offering the potential for multiple cropping.

Extensive Agriculture -- indicates areas normally with a single crop, usually but not exclusively, nonirrigated.

Range -- indicates areas where the potential natural vegetation is predominantly grasslike plants, forbs, or shrubs that can be used for grazing

Water -- indicates areas covered in water year-round--oceans, lakes, and rivers

Urban -- indicates areas of intensive use with much of the land covered by manmade structures

Forest -- indicates areas of deciduous, coniferous and mixed forest.

Orchards -- indicates areas of cultivated fruit, olive, and nut trees.

Barren -- indicates areas of land with limited ability to support plant life and loss than one-third of the area covered in vegetation.

Using the above classification system, this section of the report describes the mixture of land cover/uses present in the different regions of Syria. The originals of the photographic plates reproduced in this section of the report are in color and are included in the technical files of the sector assessment project.

Details on the methodology used for the Landsat imagery interpretation are given in Appendix 3.

Regional Patterns

Region 1 -- The Coastal Area

Region 1, the coast, extends from Lebanon north to Turkey and east to the Ghab (Fig. 1). Because this region is so diverse with mixtures of fruit and olive trees (Orchards), brush and grassland (Range), plus grains, vegetables, and tobacco (Extensive Agriculture), the separation of individual land cover/use categories was extremely difficult (see Plate I). This range of uses is represented by minor variations in red tones on a section of the coastal region shown on Plate II. This problem was further complicated by the Landsat scanner system that records dominant reflectance in an area approximately 79m by 58m (a pixel) at a time. The signatures recorded, then, represents a composite of the land cover/uses found within the pixel area (Plate III).

Plate III.--An example of the mixed brush, crop, and fruit tree cover found on the Syrian coast.

Because of this complexity, many changes from Range to Extensive Agriculture or to Orchards were not apparent on the 1972 and 1975 imagery originally used to map this area. Many of the changes that took place between 1972

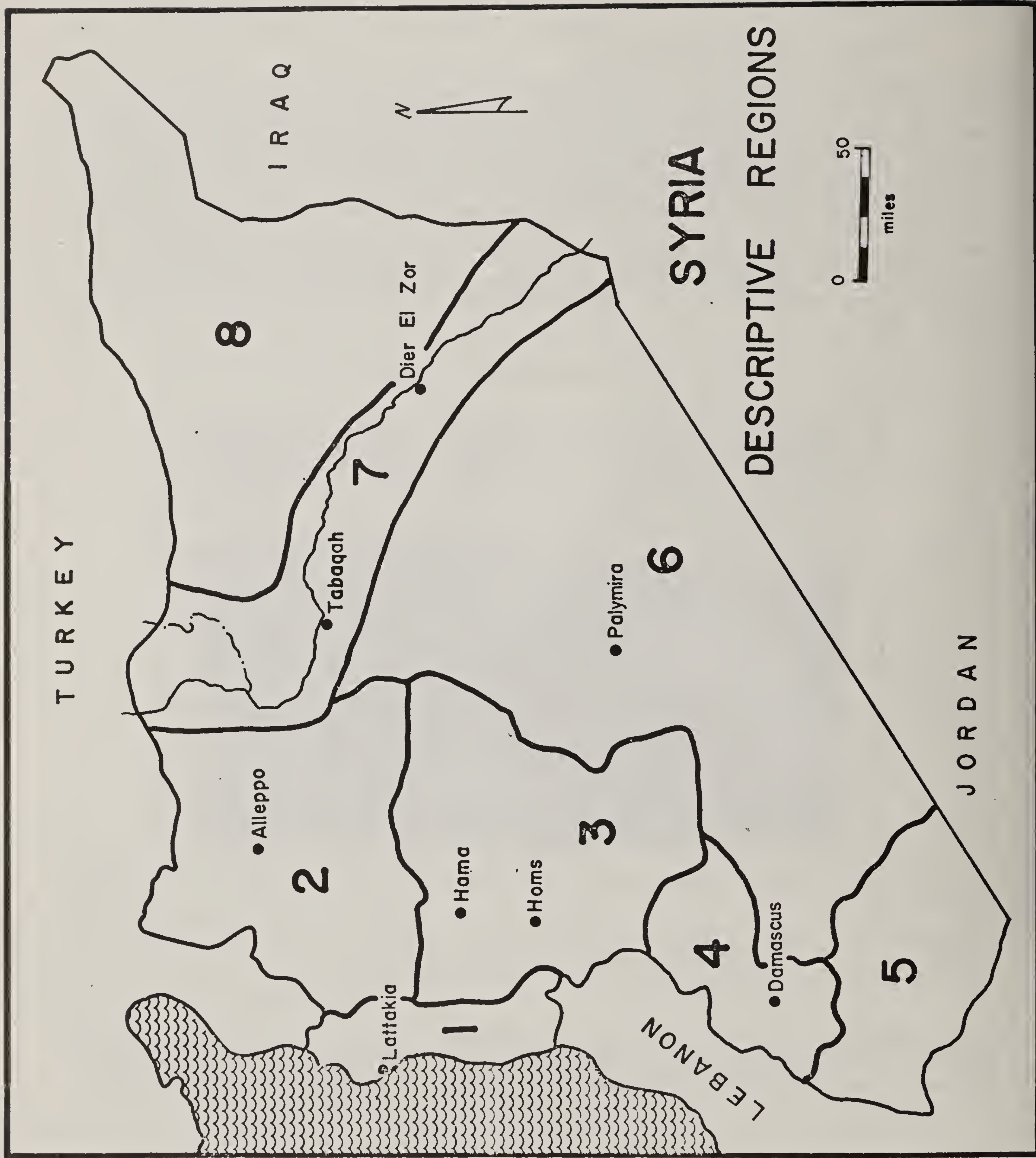


Figure 1.--A Guide to the Descriptions of Land Cover/Use by Region. (This map does not represent the interpreted land cover/use information. The land cover/use map at a scale of 1:200,000 is located in the technical files of the project.)

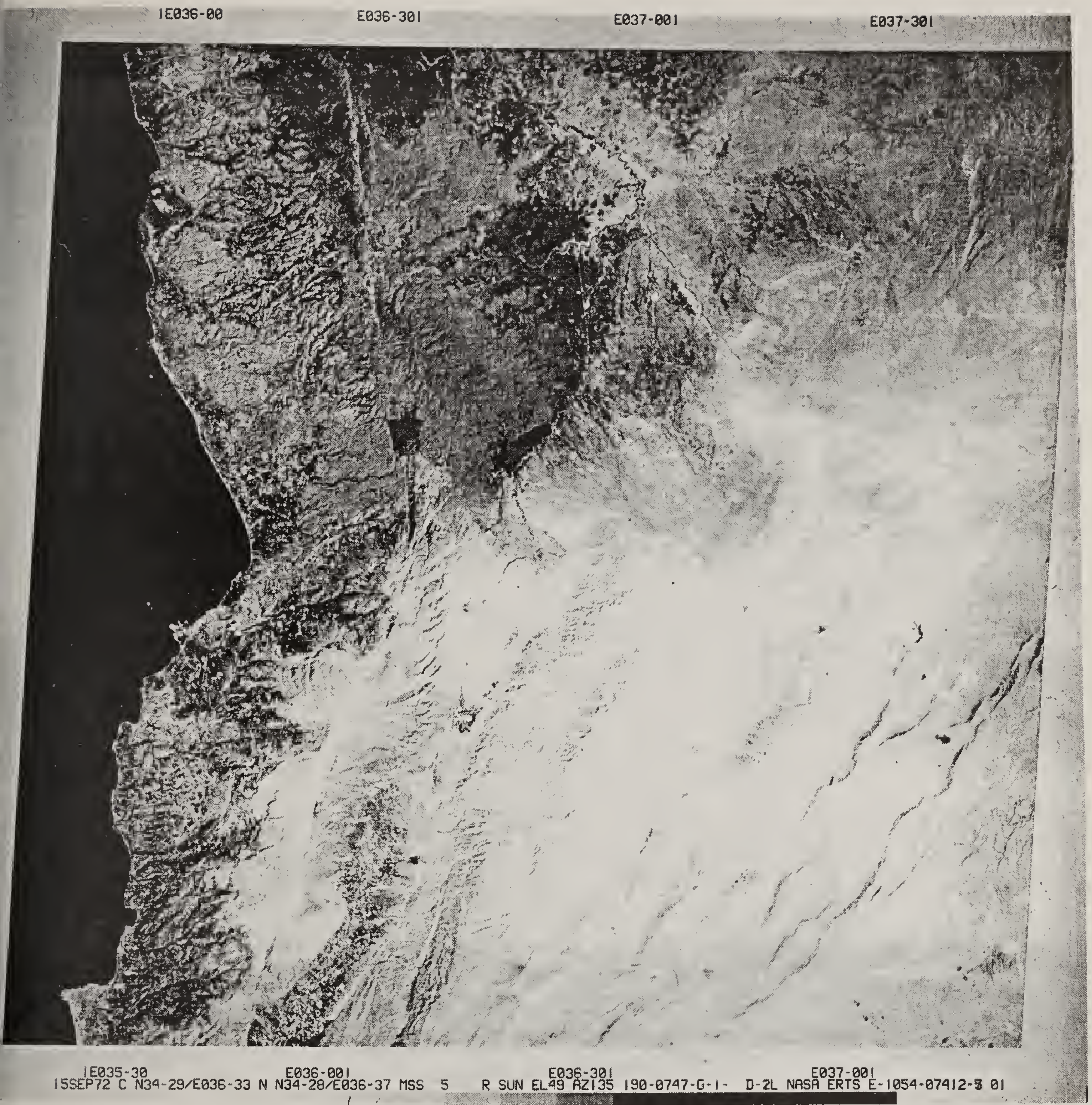


Plate I.--Landsat MSS Color Composite Frame No. E-1054-07412.

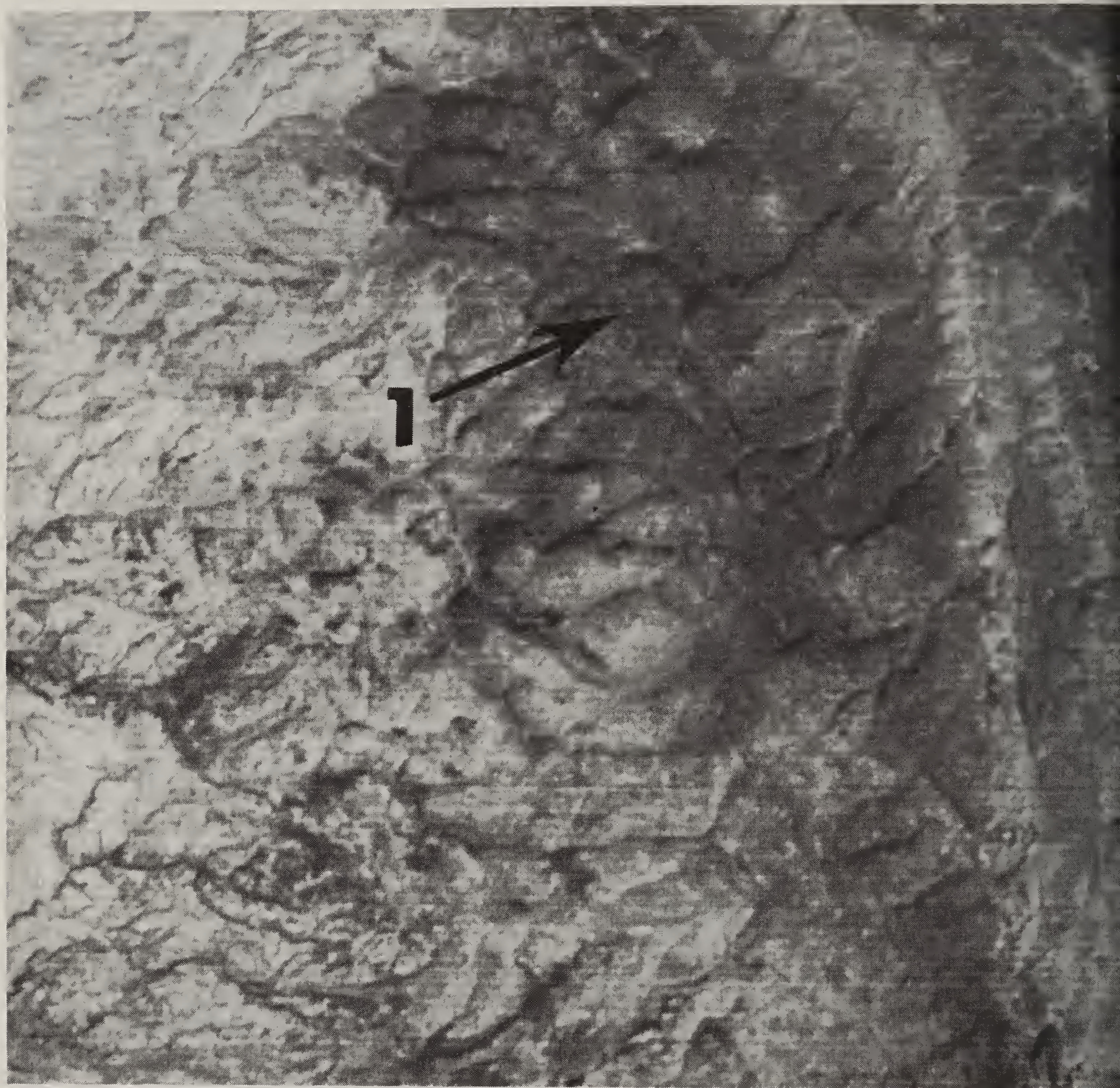


Plate II.--Mixed Crop, Orchard, and Rangeland Vegetation South of Lattakia.
Source: Landsat-1, September 15, 1972, Image ID No. E-1054-07412.

and 1978 were missed during the November/December 1978 field trip when time constraints allowed only a brief one-day reconnaissance through this area.

The area directly north and east of Lattakia is dominated by a dense cover of mixed conifer and deciduous forests. Cropping patterns found in valleys and on terraced mountain slopes are intermixed with olives, fruits, corn, tobacco, sunflowers, and brush land. The areas where this type of terrace cropping is taking place are represented in white, green, and light red in the lower left-hand corner of Plate IV. During 1975 these tones represented primarily bare soil and rock that had a more dominant refectance than the 3- to 4-year-old olive trees and the stubble left from grain crops and tobacco.

The section of the coast between Lattakia and Banias is intermixed with grassland, brush, tobacco, olives, fruit, and grain fields. The dark red tones next to the Mediterranean (left-hand corner of Plate IV, represent primarily vegetables produced under well irrigation. These irrigated areas were included in the Intensive Agriculture category. Further east into the mountains, terraced fields of wheat, tobacco, olive trees, fruit trees, and scattered forest dominate the land cover/use patterns.

In the southern section between Tartous and the Lebanese border, major changes have taken place between 1972 and 1978, from Range to Orchards, primarily olive. Fields of wheat and irrigated vegetables are also present in this section.

Region 2 -- Aleppo

The Aleppo area (Fig. 1, Region 2), was originally classified from a September 9,1975 image (Plate IV) and then updated with February, May, and September 1978 images from Telespazio. The Telespazio images, because of their poor quality, were used primarily to map the development of a proposed irrigation project along and south of the Al-Assad Reservoir (Plate IV, No. 3). This area is currently not irrigated and is being cropped in wheat and barley. It was consequently classified as Extensive Agriculture. The majority of this area is located in the Steppe, and without irrigation, only 50 percent or less of the area would be tillable yearly because of inadequate water supplies.

The wheat fields to the north and northwest of Aleppo (Plate V, No. 1) are large and intermixed with small fields of vegetables produced under well irrigation. In most instances, the small irrigated fields have as many as six different crops planted within them: corn, sunflowers, melons, tomatoes, squash, and cucumbers. Where precipitation is sufficient, a seasonal rotation of wheat and vegetables generally takes place. Further north and east where precipitation levels decline, the rotation becomes yearly.

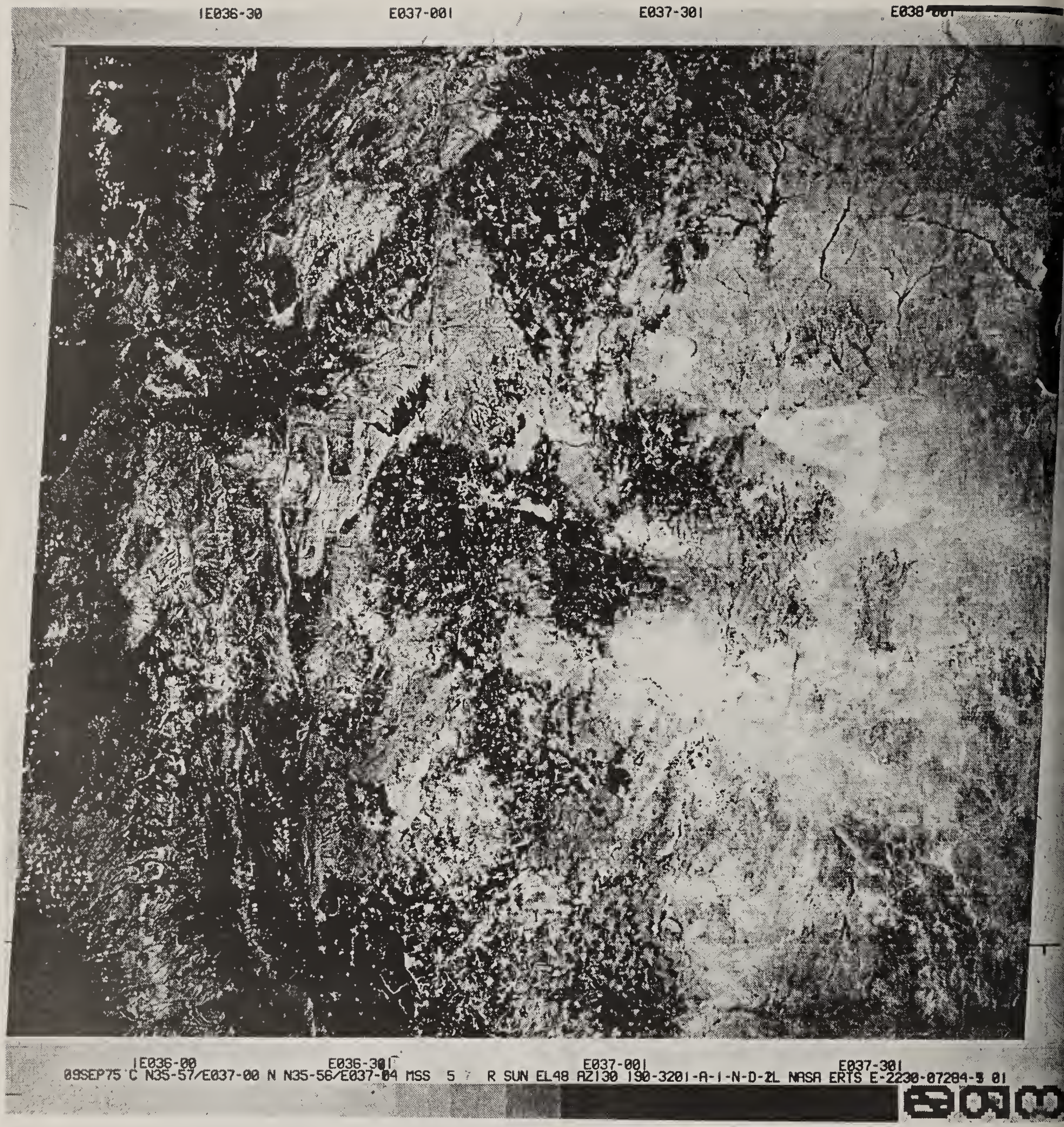


Plate IV.--Landsat MSS Color Composite Frame No. E-2230-07284.

Plate V.--Land cover/use patterns in the Alleppo area.
Source: Landsat-2, September 9, 1975, Image
ID No. E-2230-07284.

Within 40 kilometers of the Turkish border, the cropping pattern is dominated by olive orchards (Plate VI). Grapes and vegetables are intercropped between the rows of olive trees, especially where the trees are small.

Plate VI.--Olive orchards adjacent to the Turkish border.

Small plots of conifers are grown throughout the Aleppo area; however, because these trees are spaced as much as four meters apart and average one meter in height, they are not large enough to dominate the recorded reflectance in a given pixel. Consequently, these reforested areas cannot be separated from the Range and Extensive Agriculture that surrounds them.

Northeast of Aleppo, cropping patterns are similar to those found southeast of the city, where farmers are steadily encroaching on marginal lands and bringing them into production. Between Aleppo and the salt lake (Plate V, No. 2), a number of olive, nut, and fig orchards are present.

Along the Euphrates up to the Turkish border, cotton, corn, sunflowers, and vegetables are being grown. Poplar trees are also grown along the Euphrates and its tributaries. These trees are grown until they reach approximately 20cm in diameter and then harvested for building, fencing, and other commercial uses. An attempt was made to separate these trees from the Orchard and Extensive Agriculture categories and put them into the Forest category.

Region 3 -- Hama-Homs

The Hama-Homs area (Fig. 1, Region 3), in this discussion will include all mantika in these mohafazat except Tadmar. This area contains two large irrigation areas, one being the Ghab (left corner of Plate V) and one extending from Hama to Lake Homs (upper center of Plate I).

The Ghab is a stream-fed irrigation project with a tight network of feeder canals. The major crops produced are cotton, corn, sugar beets, and vegetables. Irrigation takes place primarily during the summer months for cotton production.

The mountains along the western edge of the Ghab are covered with brush. Primary use of this area appears to be to stabilize the mountain slopes to protect against erosion and to provide grazing land for local farmers. The northern section of this ridge has several fields of reforested conifers and olive orchards. A small area in the southwestern portion of the valley was being used as pasture for cattle.

The second irrigation area runs from Hama to Lake Homs, ranging in width from 8 to 16 kilometers. The soils are quite fertile and the area is normally multiple cropped. According to the Agricultural Director in Homs, the major crops are wheat, sugar beets, cotton, potatoes, vegetables, melons, grapes, fruit, and olives. Numerous plots of reforested conifers are also found, but again they were too small to dominate the reflectance pattern; as a consequence, these areas were not mapped.

West and north of Lake Homs lies an area covered with basalt rock, the brownish green tone north of Lake Homs on Plate I. Within this area a number of small fields exist where the rock has been cleared and piled into a rock fence surrounding each field. A number of small goat and sheep herds were observed crossing this area during both field trips. Accordingly, those areas not being cropped were classified as Range.

East of Hama and Homs for approximately 18 kilometers, the land cover is predominantly grain crops with a scattering of olives, range, and vegetable crops. Beyond this cultivated area, soil quality and moisture availability drop off leaving only scattered field developments where the prospect of a yearly crop is uncertain.

Region 4 -- Damascus

Region 4 (Fig. 1) includes all manatik in the Damascus City and Damascus mohafaza except Duma. Between approximately 15 kilometers south of Lake Homs and Damascus, cropping patterns are located in close proximity to each settlement. The dominant crop types found in and around these settlements are orchards, vegetables, grapes, and some grains. Clusters of these cropping patterns north of Damascus are represented in bright red hues on Plate VII.

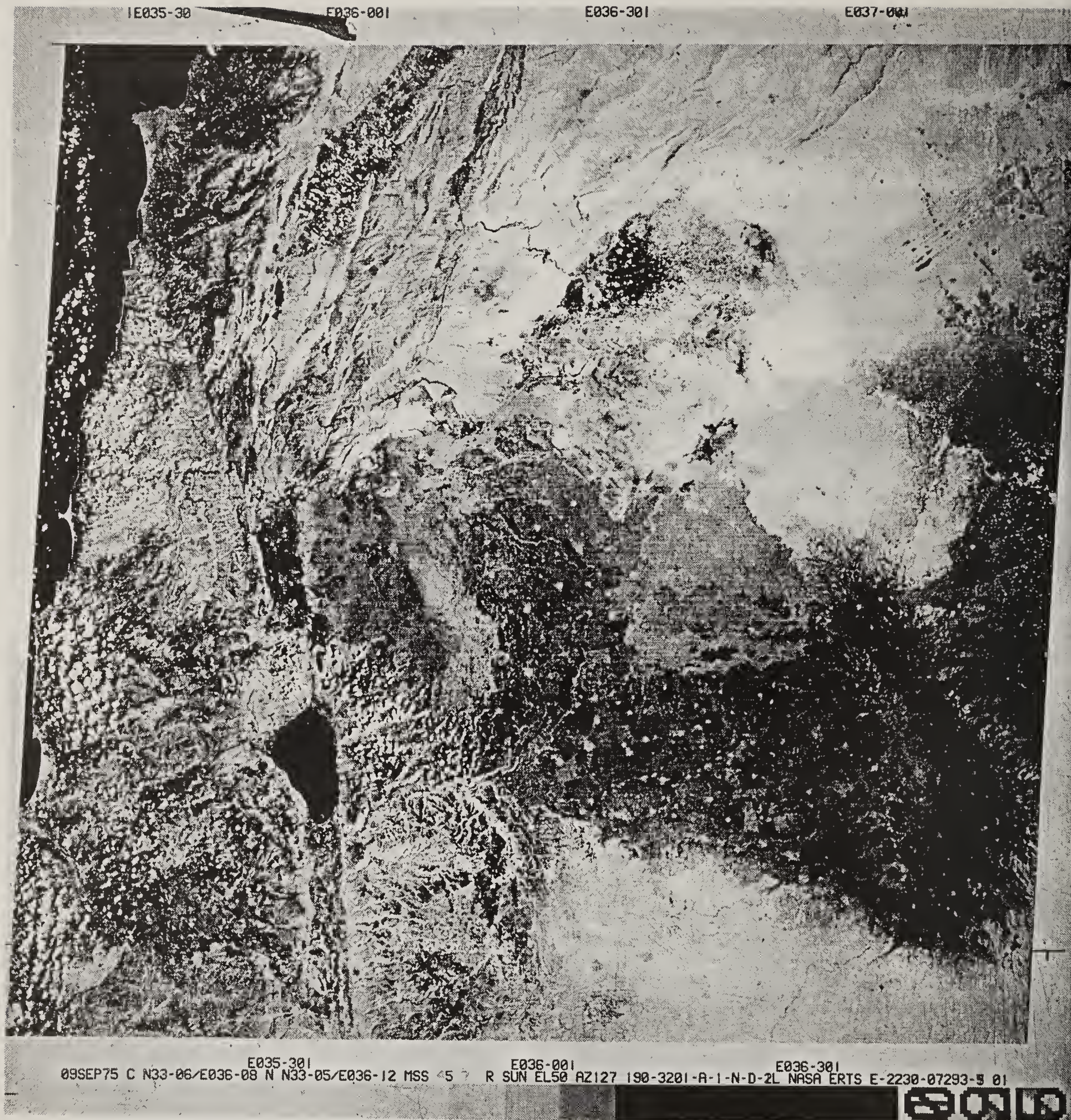


Plate VII.--Landsat MSS Color Composite Frame No. E-2230-07293.

The areas designated as 1 and 2 on Plate VIII together roughly equal the Damascus City mohafaza. Approximately half of this area represents irrigated orchards (apricots, peaches, figs, pears, walnuts, olives), some poplars, and several other less dominant crops. The less dense red tones interspersed with white were classified as Intensive Agriculture--cabbage, sunflowers, sugar beets, tomatoes, corn, onions, flowers, cotton, and other similar crops.

Scattered small urban developments are found throughout the orchards surrounding Damascus. Most industrial and small urban settlements were not distinguishable on the imagery. Two factors are primarily responsible for this; the first is the limited resolution of the Landsat sensor and second, the buildings are made from materials which vary only slightly in tone from the surrounding soils.

Region 5 -- Southwest

Region 5 (Fig. 1) encompasses the Dar'a, Al-Sweida, and Quneitra mohafazat. The area between Dar'a and Al-Sweida (Plate VII, No. 4) has a number of small fields that have been cleared of basalt rock and planted with wheat and barley. These fields are represented in dark green and were classified as Extensive Agriculture. Scattered patches of olive trees and grapevines were also found in this area.

The light bule-green tone (Plate VIII, No. 3) represents large volcanic stone that was originally classified as Range. This was done as a result of the first field trip when several small goat herds were observed grazing among the rocks. However, after reconsideration, it was felt that this area would more appropriately be classified as Barren.

Tone, texture, and pattern were the only bases for land cover/use classifications in the Quneitra mohafaza because it was impossible to travel this area. Based on comments by Syrian counterparts, little difference is expected between tones of land features in Dar'a and Quneitra.

Region 6 -- Southeast

Tadmar and Duma manatik were separated from their mohafazat into Region 6 (Fig. 1) because the land cover is almost completely desert vegetation. Previously discussed regions were either totally cropped or had transition zones along their easter boundaries. Transition zones are characterized by yearly cropping patterns changing to periodic yearly cropping and then finally to desert, from west to east. In this region, the majority of the plowed fields are located along the road between Homs and Palmyra, and most are reported to be successfully cropped only once in a ten-year period (Plate IX) due to sporadic and sparse precipitation. Small fields of irrigated cotton and vegetables are also intermixed and produce crops yearly. Many of these fields experience salt build-up unless properly flushed and drained.

Plate VIII.--Land cover/use patterns in the Damascus area. Source: Landsat-2, September 9, 1975, Image ID No. E-2230-07293.

Plate IX.--Plowed field in the Steppe.

A number of fig and olive orchards are found within Palmyra and surrounding the city are fields of vegetables, grains, and grapes. South and west of Palmyra is a large intermittent salt lake with almost no agriculture. Several small areas east of Palmyra have been reforested with small deciduous trees, but these trees are not large enough to dominate reflectance patterns and could not be mapped.

Region 7 -- Euphrates

Region 7 (Fig. 1) corresponds to the main part of the Euphrates River where irrigated cotton dominates the cropping patterns from the Turkish border to Al-bu Kamal (Plate X, No. 2). Plate XI shows cotton being harvested during the November/December 1978 field trip. The northern tributaries of the Euphrates River (Plate XII) have numerous small fields of cultivated poplar trees growing along their banks. These trees are harvested when they reach approximately 20cm in diameter. The gray-green tones surrounding the cotton fields are a result of the high reflectance characteristics of the desert soil (Plate XI, No. 3). A higher reflectance pattern occurs between Deir-ez-Zor and Al-bu Kamal, south of the Euphrates River, and represents areas of high salt concentrations.

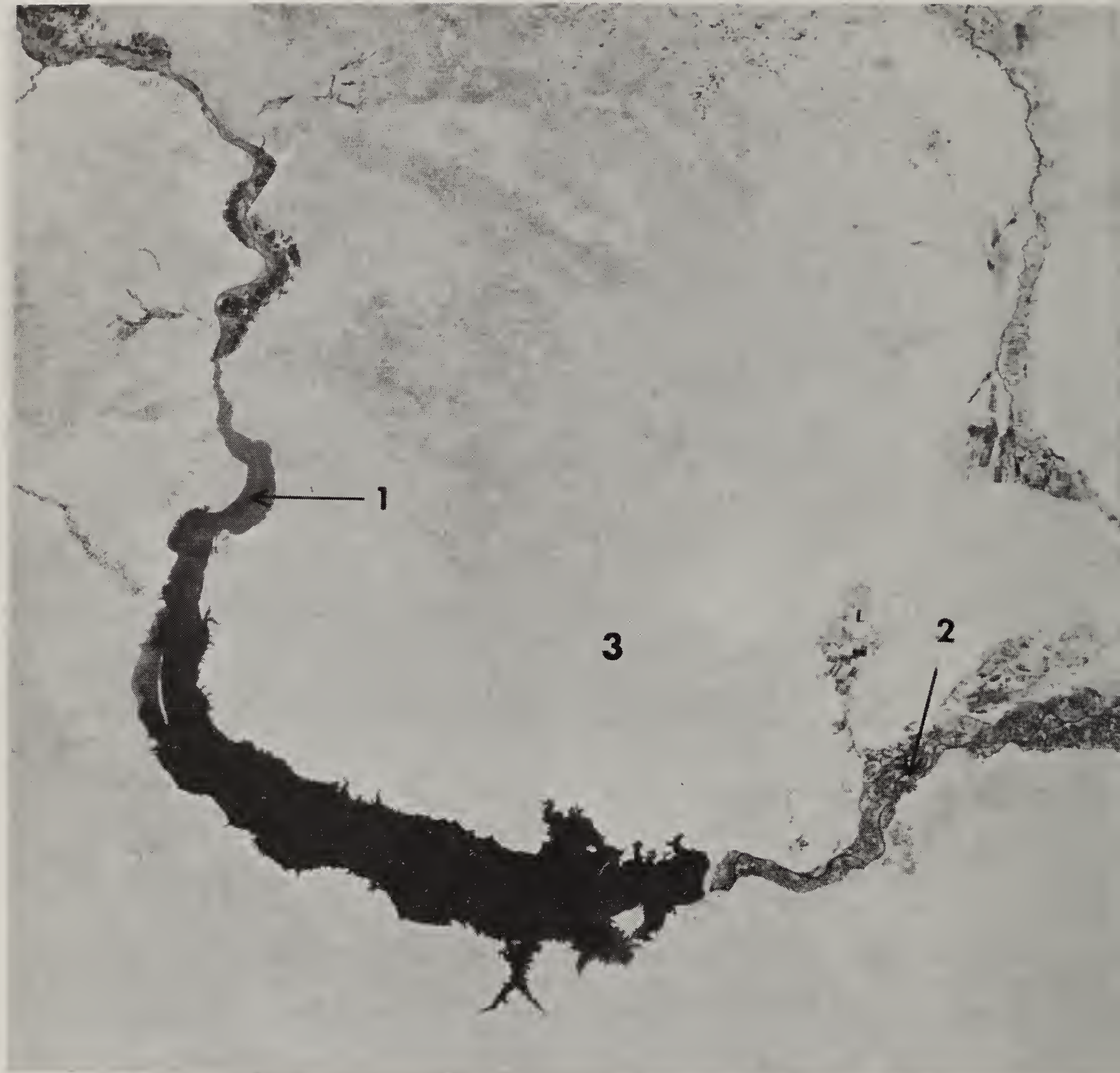


Plate X.--Land cover/use patterns surrounding the El Assad Reservoir Area.
Source: Landsat-2, July 28, 1976, Image ID No. E-2553-07163.

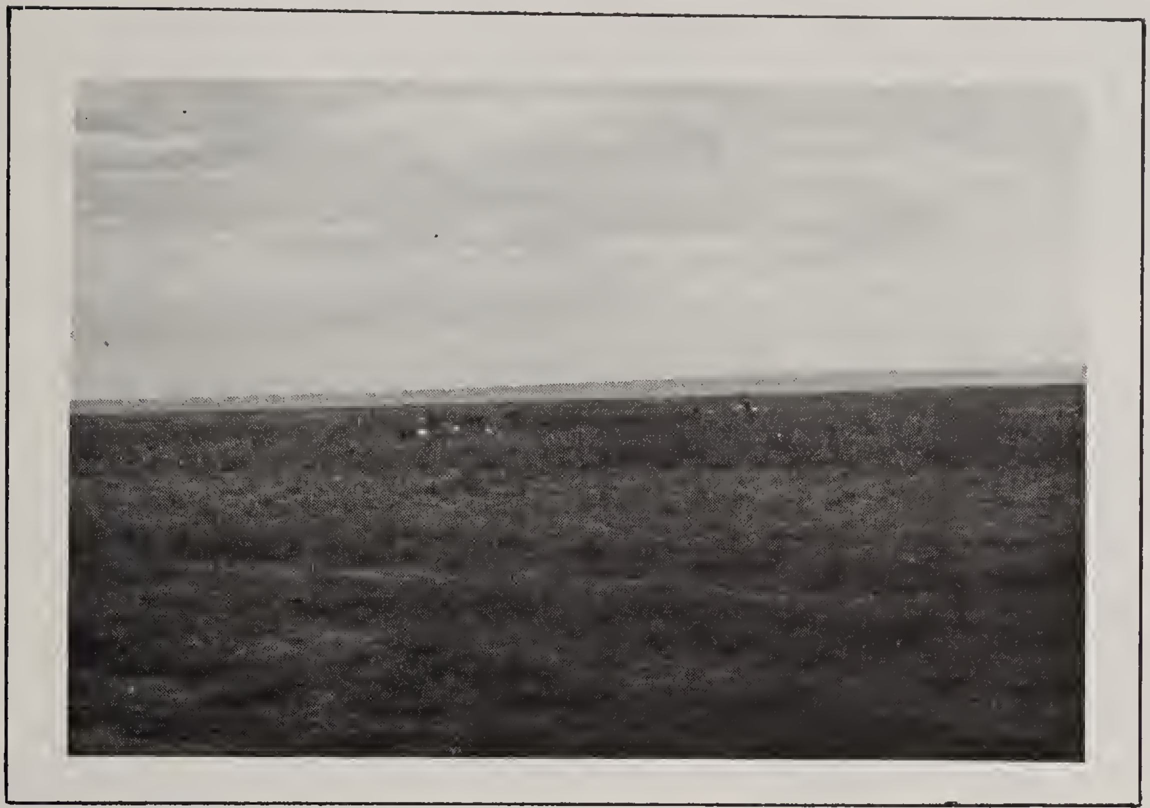


Plate XI.--Irrigated cotton field during harvest.

Region 8 -- Northeast

Region 8 contains portions of Al-Hasakeh, Al-Rakka, and Deir-ez-Zor mohafazat (Fig. 1). This region's cropping patterns are dominated by large wheat and barley fields. This pattern has shown a steady increase from 1975 to 1978, particularly in the area immediately north of the Euphrates River that was previously Range. Irrigated cotton is also grown in this region along the Khabour River.

According to the Al-Hasakeh Agriculture Director, since 1975 fruit trees have been planted in what were previously wheat fields in areas adjacent to the city of Al-Hasakeh. He also indicated alfalfa and other feed crops and pine trees were being planted in his district. Again, reforested pine and orchard trees were too small to sufficiently dominate the reflectance pattern and allow separate delineations.

Plate XII.--Landsat MSS Color Composite Frame No. E-2553-07163.

Area Totals

When considering the final totals for the interpreted land cover/use in Syria some assumptions were made in the actual interpretation process that need to be kept in mind. First, the classification scheme used in the interpretation was designed to be general in nature, to emphasize agricultural categories and be compatible with both project needs and the land use information gathered by the Syrian authorities. Second, areas smaller than 0.5 km^2 (the minimum type size) were not separately delineated in the interpretation process and, as a consequence, were included in adjacent land cover/use types. This generalization process is most significant in the smaller categories, such as Intensive Agriculture and Urban, where a very slight underestimation can be anticipated. A third and related problem involves the methodology used in converting the delineated land cover/use map through the geocoding process to a computer file. The land cover/use type for each 1 km^2 grid cell was obtained by sampling the delineations using a dot grid. In this way small individual delineations, such as Extensive Agriculture areas in the Steppe may be completely missed, or overestimated depending on how the grid was aligned over a specific field. Since this is a sampling technique, the error is distributed among the categories and does not pose a problem when national totals are being considered. If the information is to be applied to specific categories in small areas where totals for Intensive Agriculture, Water, or Urban are of importance, it is recommended that area totals be measured from the delineations on the 1:200,000 land cover/use maps using a planimeter.

The extent of each land cover/use category is presented as an area total in km^2 and as a percentage of the country total (Table 1).

Table 1.--Interpreted Land Cover/Use Category Totals. (For definitions of land cover/use categories, see page)

Interpreted Land Cover/Use Category	Area Total km^2	%
Intensive Agriculture	6,828	3.6
Extensive Agriculture	50,226	26.8
Range	122,845	65.7
Water	1,014	0.5
Urban	290	0.2
Forest	1,498	0.8
Orchard	1,875	1.0
Barren	2,617	1.4
Country Total	187,193	100.0

Interpreted and Statistical Data

The Major Land Use Categories found in the Annual Agricultural Statistical Abstracts are split into four major categories. Definitions of categories found in these abstracts are:

1. Forest: land covered by natural forest trees or afforested by man.
2. Steppes and Pasture: land covered with natural or man-established pasture and grass, including gardens, public squares and public permiteed pastureland.
3. Uncultivable Lands: lands which cannot be cultivated.
   a. Buildings and Public Roads
   b. Marshes, Lakes, Rivers
   c. Rocky and Sandy Land
4. Cultivable Land: land which can be cultivated and planted with trees or crops or fallowed.
   a. Cultivated: land usually in agricultural rotation
      i) perennial or seasonal crops
      ii) land fallowed for two years or less
   b. Uncultivated: land which can be cultivated if some form of land improvement preceeds cultivation.

The following theoretical correspondence between the two sets of land use definitions, for purposes of comparison, is presented.

Interpreted Categories	Reported Categories
Intensive Agriculture + Extensive Agriculture + Orchards	Cultivable Land (cultivated + uncultivated.
Range	Steppes and Pasture
Barren	Rocks and Sand
Water	Water
Urban	Buildings and Roads
Forest	Forest

Applying this theoretical correspondence directly to the statistical information demonstrates some incongruity between the two sets of information (Table 2.A.). The cultivable land categories are in very close agreement but interpreted Range substantially overestimates reported Steppes and Pasture, while interpreted Barren substantially underestimates reported Rock and Sand.

The problem lies within the operational definitions of these categories adopted during the interpretation process. Range was defined to include land that could potentially support grazing activity. Field information and supplemental material did not allow the interpreters to distinguish grazing from nongrazing activity in the Stepee areas; consequently all of this land was classified within the Range category. The reported information does distinguish between grazing lands categorized as Steppes and Pasture, and non-grazing categorized as Rocks and Sand. This distinction then, separates areas in the reported information which are combined in the interpreted totals, thus causing both the overestimate and the underestimate. For example, in Deir-ez-Zor mohafaza which is predominantly Steppe, the mapped information indicates approximately 1298 km^2 in Barren and 21,620 km^2 in Range for a total of 22,918 km^2, while the reported information indicates approximately 11,881 km^2 in Rocks and Sand and 9758 km^2 in Steppes and Pasture for a total of 21,639 km^2. The combined totals are close and while this definitional problem does cause some loss of interpretative quality in the mapped infortion, combining Steppes and Pastures with Rocks and Sand for purposes of comparison, does bring the mapped information into close correspondence with the statistical information at the national level (Table 2).

The underestimates of Forest and Urban land in the mapped information can also be tied to interpretation and classification system related factors. Reported Forest totals include areas of brush and afforested lands. Neither of these subclasses could be separately distinguished from the imagery and were included in the Range category. This operational definition then simultaneously underestimates Forest in the mapped information, and also adds marginally to the mapped Range totals. Urban is underestimated because the 0.5 km^2 minimum type size used in the interpretation eliminated recording roads and many of the small villages. In addition, some villages particularly in the Steppe area were not delineated because the tonal variation between the building materials and the surrounding soil was so slight.

Land Cover/Use By RPU

Analysis of resource problems is often facilitated by looking at land cover/use information that has been subdivided into distinct spatial units appropriate to the problem under consideration. Cross tabulation of land cover/use categories by Resource Planning Units (Table 3) is an example of such a procedure. The current use of the land is summarized by the planning unit so that a comparison between this use and the potential use, as indicated in the RPU description, can be made.

Land Use and Recommended Crops

Land cover/use as interpreted from Landsat can be compared with recommendations by crop group and the recommended most intensive land use from the detailed RPU descriptions given in section B. above. The comparison highlights the presence or absence of correspondence between the current major agricultural land cover/use pattern and the recommended use, where the recommended use

Table 2.--Comparison of Interpreted Land Cover/Use and Reported Land Use Information from the Syrian Statistical Abstracts.

	Mapped Information	Reported[1] Information	Difference (Mapped-Reported)	Percent Difference
	km^2			
A.				
Intensive Ag., Extensive Ag., Orchards (cultivable land)	58,929	58.728	+ 201	+ 0.3
Range (Steppe & Pasture)	122,845	85,420	+ 37,425	+ 43.8
Barren (Rocks & Sand)	2,617	32,740	- 30,123	- 92.0
Water	1,014	1,027	- 13	- 1.3
Urban	290	2,736	- 2,446	- 89.4
Forest	1,498	4,540	- 3,042	- 67.0
Total	187,193	185,191	+ 2002	+ 1.1
B.				
Cultivable Land	58,929	58,728	+ 201	+ 0.3
Range (Steppe & Pasture, Rocks & Sand)	125,462	118,160	+ 7,302	+ 6.2
Water	1,014	1,027	- 13	- 1.3
Urban	290	2,736	- 2,446	- 89.4
Forest	1,498	4,540	- 3,042	- 67.0
Total	187,193	185,191	+ 2002	+ 1.1

1. Annual Agricultural Statistical Abstract: Syria 1976 and 1977.

Table 3.--Interpreted Land Cover/Use Information by Resource Planning Units.

RPU	LAND COVER/USE CATEGORY (KM^2) Intensive Ag.	Extensive Ag.	Range	Water	Urban	Forest	Orchard	Barren	RPU Total
1	0	28	8,977	0	0	0	0	646	9,651
2	0	792	248	1	8	0	0	783	1,832
3	107	2,347	722	1	35	0	1	67	3,280
4	0	1,026	459	0	17	0	0	63	1,565
5	18	712	1,093	0	3	0	8	0	1,834
6	9	393	159	9	0	0	0	0	570
7	0	5	24,073	0	0	0	0	0	24,078
8	153	133	626	0	3	0	18	7	940
9	35	42	1,319	0	55	0	184	0	1,635
10	331	47	251	15	4	0	36	0	684
13	0	57	2,814	1	4	0	0	18	2,894
15	0	40	1,391	1	2	0	67	0	1,501
16	0	0	29	0	1	0	41	0	71
17	0	4	1,939	0	1	0	0	0	1,944
18	0	105	5,478	0	12	0	0	89	5,684
19	17	90	13,058	7	0	0	0	0	13,172
20	312	3,714	4,190	11	44	0	12	47	8,330
21	0	101	1,101	0	2	0	0	0	1,204
22	0	56	387	0	0	0	0	0	443
23	2	334	48	0	0	0	0	0	384
24	38	523	302	44	2	0	0	0	909
25	108	829	1,045	5	3	5	25	0	2,020
26	820	2,411	284	3	37	0	276	4	3,835
27	8	22	223	1	0	0	0	0	254
28	183	443	78	1	12	1	208	0	926
29	0	35	195	0	0	8	10	0	248
30	42	2,027	105	1	0	1,024	572	0	3,771
31	724	3,423	36,737	77	15	0	0	580	41,556
32	1,425	234	1,520	251	0	0	0	0	3,430
33	0	11	313	0	0	0	0	280	604
34	563	81	127	8	2	79	0	0	860
35	0	210	7	0	2	190	16	0	425
36	93	500	1,137	0	2	184	159	0	2,075
37	215	57	270	0	1	0	1	0	544
38	34	2,254	293	1	1	1	0	0	2,584
39	71	264	1,979	151	3	0	0	0	2,468
40	500	1,062	1,014	327	0	0	0	8	2,911
41	25	267	851	0	0	0	0	1	1,144
42	92	550	261	7	2	0	0	0	912
45	2	604	789	0	0	0	0	0	1,395
46	273	7,169	2,746	8	6	0	0	8	10,210
47	17	214	93	0	2	6	155	0	487
48	46	2,967	917	38	0	0	0	4	3,972
49	120	732	18	1	0	0	0	0	871
50	245	1,652	38	0	0	0	0	0	1,935
51	0	1,237	990	0	0	0	0	11	2,238
52	2	4,619	0	0	4	0	0	0	4,625
53	0	1,405	0	0	1	0	0	1	1,407
54	0	1,435	123	3	0	0	0	0	1,561
55	0	151	160	0	0	0	0	0	311
56	0	399	4	0	1	0	0	0	404
57	198	2,359	1,558	41	0	0	0	0	4,156
58	0	54	306	0	3	0	86	0	449
Land Cover/Use Totals	6,828	50,226	122,845	1,014	290	1,498	1,875	2,617	187,193

affords maximum sustained production of cultivated crops or permanent vegetation consistent with the potentials and limitations imposed by soils and climate. The major land cover/use categories Intensive Agriculture, Extensive Agriculture, and Orchards are used to identify the actual agricultural patterns. Crop group recommendations and recommended most intensive land use are derived from fundamental agronomic principles and information used to delineate Resource Planning Units (RPUs).

Intensive Agriculture. The interpreted land use category "Intensive Agriculture" represents land usually under irrigation. RPUs with major "Intensive Agriculture" land areas (over 100 km^2) are, largest to smallest, 32, 26, 31, 34, 40, 10, 20, 46, 50, 37, 57, 28, 8, 49, 25, and 3. The recommended most intensive land use suggests that most of these Resource Planning Units or, at least, a portion of their component Production Potential Areas, are areas rated with medium to high production potential under irrigation for various crop groups. Exceptions to these ratings are RPUs 28, 37, and 57. RPU 28 is rated with medium to high production potential without irrigation, although supplemental irrigation may be used to ensure optimum yields. Irrigated agriculture is not considered the most desirable intensive land use in RPUs 37 and 57 due to soil erosion problems.

Extensive Agriculture. The "Extensive Agriculture" category generally implies nonirrigated agricultural areas where only one crop (or fallowed) is expected in a one-year period. Several RPUs were interpreted to have more than 1,000 km^2 of "Extensive Agriculture." Ordered from largest to smallest, those RPUs are 46, 52, 20, 31, 48, 26, 57, 3, 38, 30, 50, 54, 53, 51, 40 and 4. The following RPUs or a portion of their component Production Potential Areas (PPAs) are considered to have medium potential for rainfed small grains: 52, 20, 48, 26, 50, and 53. Oil crops are considered to have medium potential in RPUs 38, 48, 53, and 54. RPUs 20 and 26 have medium potential for pulses and RPU 20 is also considered to have medium potential for grapes.

Several other RPUs are considered to have medium to high potential for nonirrigated agriculture for various crop groups; however, theri areas of "Extensive Agriculture" were less than 1,000 km^2. The total area interpreted to be Extensive Agriculture in the Syrian Arab Republic is 50,226 km^2. Although considerable Extensive Agriculture is apparent in many RPUs, the production potential under improved practices for rainfed agriculture is considered limited primarily because of rainfall.

Orchards. Land area interpreted as Orchards was found in 18 RPUs totaling an estimated 1,875 km^2. Those RPUs with more than 10 km^2 interpreted as Orchard land are, from largest (572 km^2) to smallest (12 km^2), RPU 30, 26, 28, 9, 36, 47, 58, 15, 16, 10, 25, 8, 35, and 20. Those RPUs with more than 100 km^2 of area interpreted as Orchards were 30, 26, 28, 9, 36, and 47.

For the nonrosaceous fruit group that includes figs, pistachios and pomegranates, medium to high production potential under irrigated conditions is reported for the following RPUs which wre interpreted to have more than 10 km^2 of Orchard: RPUs 8, 9, 16, 10, 20, 26, 35, and 47; under rainfed conditions, RPUs 20, 28, 35, 36, and 58 have medium to high production potential.

For the rosaceous fruit group (almods, apricots, apples, cherries and peaches), medium to high production potential under irrigated conditions is reported for the following RPUs which were interpreted to have more than 10 km^2 of orchards; RPUs 8, 9, 16, 20, 25, 26, and 35; under rainfed conditions RPUs 20, 25, 35, 36, and 58 have medium to high production potential.

RPUs 28 and 36 are considered to have high and medium potential, respectively, for citrus production under rainfed conditions. Those RPUs with more than 10 km^2 interpreted as Orchards and considered to be either medium or high potential for olive production are RPUs 8, 9, 16, 10, 20, 25, 26, 28, 35, 36, 47 and 58.

Appendix 1

Land Resource Classification

A. Introduction

In order to analyze the agricultural land resource base and its patterns of land use, an Agricultural Resource Information System was designed for Syria. This system is composed of two subsystems -- the Land Information Subsystem, which spatially identifies the extent, general resource characteristics, and major uses of the resources; and the Agro-Economic Information Subsystem, which incorporates information on the area, production, and yield of major crops and on intensity of land use by administrative units.

Detailed procedures for the development of the Land Information Subsystem are presented in Appendix 2 of this chapter. The information included and the procedures for developing the Agro-Economic Information Subsystem are described in the Appendix to chapter I of the Agricultural Production Annex.

Information contained in the Land Information Subsystem will provide the Syrian Arab Republic Government with additional capability for exploring national questions about current and potential capacity to produce alternative levels and mixes of agricultural products and associated levels of employment, income, and foreign exchange. The land resource base assessment will provide a partial basis for assessing the comparative advantage of the various resources in the production of agricultural commodities. The information on land use will provide a partial basis for doing comparative impact analysis of alternative programs and policies to evaluate the comparative advantage in the use of the agricultural resource base.

As a first step in providing for analyses of comparative advantage in the use of agricultural resources, it is necessary that the land resources be inventoried and aggregated into areas (land resource units) for which reasonable, unique estimates about land use, crop adaptations, crop productivity, management practices, and development options can be made. To facilitate incorporation of the land resource information into the Land Information Subsystem, it is also necessary that these resource units be geographically identified so they can be cross-referenced with other information on resource use, production practices, administrative boundaries, and other information essential to assessing production potential and useful for planning, policy and program analyses, and implementation.

The need for both a homogeneous resource area and a geographically identified resource planning unit requires the use of a two-level system of land resource classification to accommodate these information management and analytical needs. The homogeneous resource unit is called a production potential area (PPA). The unit that is geograpically and cartographically identified to facilitate information management is called the resource planning unit (RPU).

The concepts and definitions of PPAs and RPUs reflect the relationships among soils, climate, and plant growth. Soil resources are stratified according to the U.S. Department of Agriculture's Soil Taxonomy.[1/] Agro-climatic characteristics were

[1/] Soil Taxonomy, A Basic System for Soil Classification for Making and Interpreting Soil Surveys. Soil Conservation Service, USDA. Ag. Handbook No. 436, December, 1975.

reviewed judgementally using available publications and other reference materials and through field reconnaissance. Agricultural production requires the presence of naturally-occurring factors such as soil, temperature, water, light, etc. in the general proportions needed by plants. These interrelated factors are frequently grouped into two components -- soil and climate -- to simplify the problem of estimating the impacts of the environment on the adaptability and vigor of economically important plants.

The interrelated nature of soil and climate in the physiographic and biologic environment is recognized. Soil characteristics such as broad moisture and temperature regimes, the presence or absence of diagnostic horizons and soil properties, and other factors such as parent materials and relief give rise to differences among individual soils. These factors differentiate unique characteristics of the various kinds of soils and, in turn, affect the adaptability and vigor of plants. Variations in climate caused by such factors as altitude and seasonality are reflected in the distribution of specific plant species within broad vegetative patterns. Among the climatic factors often considered important to crop adaptability and productivity are day length, annual temperature, annual precipitation, seasonality of precipitation, intensity of precipitation during the wet season, and mean monthly temperature during the wet season. Additionally, the presence or absence of frost during the growing season is of extreme importance. The discrimination of plants for an optimum growing environment defined in terms of soils and climate make feasible the delineation of resource units suitable for agricultural planning.

Discussed in subsequent sections are additional materials relative to the soil and crop climate characteristics that underlie the resource planning unit and production potential area descriptions, including citations for source materials. The final section provides a discussion of major crop recommendations made by production potential area.

B. Soils

The principal source used was the work of W.J. van Liere, both the 1:200,000 scale soil maps and the smaller scale 1:500,000 soil map compilation made from them. These maps provided the basis for delineating areas of kinds of soil on the soil map to be compiled. A list of principal sources is provided at the end of this section (Attachment B-1). Syrian soil scientist counterparts supplemented the documentary material with data from their personal knowledge and experience. Some of these data were gathered on special forms and applied to the map units on van Liere's Soil Map of Syria. The form used for the collection of these data is also included at the end of this section (Attachment B-2).

In the previously published works, several systems of classifying soils had been used. By using descriptive materials that were available, the soils were reclassified in terms of a common system, the taxa of Soil Taxonomy. Brief descriptions of selected categories of Soil Taxonomy are provided at the end of the section (Attachment B-3). For those areas for which no pedological classification was available, classification was inferred from available data on geology, climate, vegetation, topography, and geologic age. Data were sufficiently meager that the derived classifications can, in some instances, be considered tentative pending completion of additional and more comprehensive studies.

Landscapes were characterized in terms of ranges of slope and nature of the underlying materials. The former were estimated from topographic maps of 1:200,000

scale available in Syria and those of 1:250,000 scale available in the United States. The nature of the underlying materials was obtained from sources dealing with geology and information available in legends of soil maps.

Map units on the newly compiled soil map are identified by a three-part symbol identifying the dominant soil in the delineation, the range of slope on which it occurs, and the nature of the underlying material. Thus, in the map unit symbol DOAh U/LS, DOAh identifies the dominant soil in the map unit as Lithic Camborthids; U indicates undulating topography; and LS identifies limestone as the underlying bedrock. The legend of the soil map showing map unit symbols and the names of the respective map units are provided at the end of this section (Attachment B-4). Symbolization is an unofficial system conceived for in-house use on 1:1,000,000 soil maps compiled by soil scientists of the Soil Conservation Service, U.S. Department of Agriculture.

The base soil map consisted of the 26 sheets of the 1:200,000 topographic map of Syria. Soil map units were delineated on mylar overlays. For purposes of a more general, overall view of the distribution of map units on a national basis, the overlays were photographically reduced to a scale of 1:750,000 and a composite overlay prepared to fit the 1:750,000 general reference map of Syria. Soil map units have been depicted at a scale of 1:500,000 (4 sheets) for display purposes (and are available on request).

C. Climate

Climatological data were used in conjunction with the soils information in the delineation of the RPUs and in the specification of PPA characteristics within RPUs. A list of principal sources for the crop-climate delineations is provided at the end of the section (Attachment C-1).

Data from 175 weather stations were considered in preparation of a description of the climatic characteristics of the PPAs. From the available data monthly average precipitation was evaluated to determine the intensity of any wet season. Generally, abrupt increases in monthly precipitation were easy to note and to use to define wet seasons. The simple formula:

$$P_m = \frac{P_1 + P_2 \ldots P_n}{n},$$

where P_m is the average monthly precipitation during the wet season, P_n is the average precipitation for the n-th month, and n the total number of months in the wet season, was used to describe the wet season precipitation characteristics within the PPAs. These values are reported in parentheses, (), by PPA in the table accompanying each RPU description. When weather stations data were unavailable for a particular PPA, an estimate of the average monthly precipitation during the wet season was made through the consideration of precipitation characteristics of similar areas. These estimates are denoted in the detailed descriptions of PPAs by the sign (@).

Mean annual precipitation was calculated from weather station data where available for a particular PPA. These values are reported in parentheses by PPA in the table accompanying each RPU description. The mean annual precipitation reading interpolated from the appropriate map in the Climatic Atlas of Syria is also reported by PPA and denoted by the sign (#).

Data from some 75 weather stations for which monthly temperature data were available were used to calculate average monthly temperature during the wet season. For those PPAs for which weather station average monthly temperature data were available, the following formula was applied:

$$T_w = \frac{T_1 + T_2 \ldots T_n}{n} ,$$

where T_w is the average monthly temperature during the wet season, T_n is the average temperature for the n-th month, and n the total number of months in the wet season. T_w values were reported, and included in parentheses, (), for those PPAs where weather station data were available. Average monthly temperature values were interpolated from the appropriate maps in the Climatic Atlas of Syria. These estimated values are denoted in the detailed descriptions of PPAs by a plus (+).

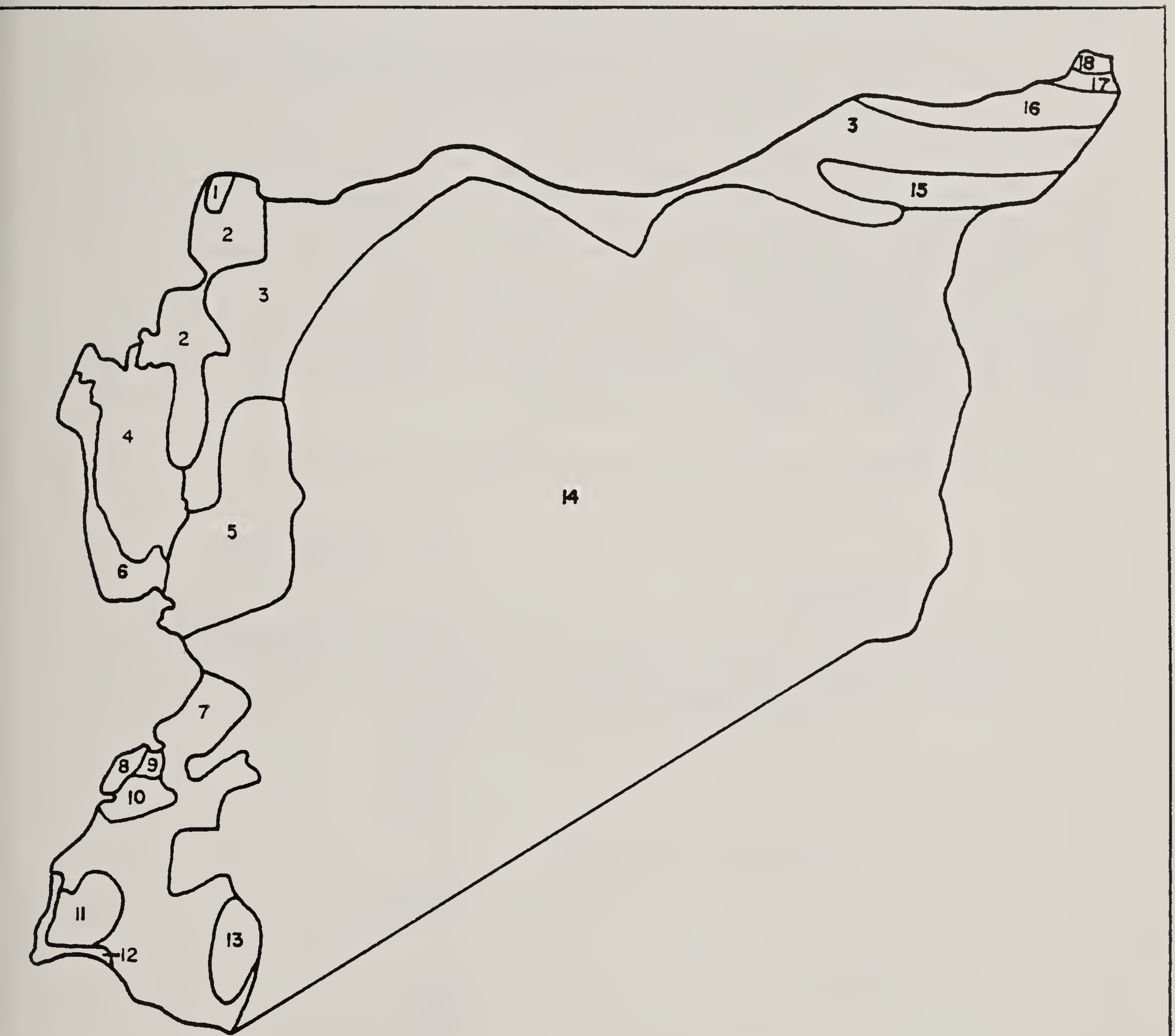
Mean annual temperature was calculated from weather station data where available for a particular PPA, and reported in parentheses, (), in the table accompanying each RPU description. The mean annual temperature, as interpolated from the appropriate map in the Climatic Atlas of Syria, is reported by PPA and denoted by the sign (#).

The reader should recognize that when point estimates (weather station) of mean annual temperature and precipitation and mean monthly temperature and precipitation during the wet season are calculated from weather station data, such values represent a point in the PPA. The representativeness of these values for an entire PPA are dependent on the location of the weather station within the particular PPA.

All weather stations were located at points corresponding to the locations labelled on working maps. Weather stations were used to form the nuclei of the crop climate map units (Figure 1). Each of the 18 map units was delineated by drawing lines between nuclei made up of one or more weather stations with similar annual and wet season climatic characteristics. A brief description of each of the 18 crop climate map units is provided (Attachment C-2). The positions of these lines on the map were fixed by a judgemental process. Input to this process included field examination of terrain for changes in vegetation and cropping practices. Topography was also taken into account. Existing floristic materials, especially floristic maps, were also used in fixing the lines.

Crop climate map units delimited in the fashion described above were recorded on working copy mylar overlays using the 1:200,000 topographic maps of Syria (26 sheets) as the base. Each map unit depicts areas of similar annual climatic characteristics and/or depicts associations of climatic areas of similar wet season characteristics occurring in repeating patterns across areas. It should be noted, however, that the boundaries of the map units do not guarantee that the climate characteristics specified for a map unit will never occur outside the map unit. That is, there may be inclusions of a similar climate in other crop climate map units. Crop climate map units have been depicted at a scale of 1:500,00 (4 sheets) for display purposes (and are available on request).

Figure 1. -- Crop Climate Map of Syria



D. Crop Recommendations

Major crop recommendations are made by PPA. They are intended to denote where major crops or major crop groups are adapted and provide some indication of yield potential under alternative management levels.[1] Ratings are qualitatively expressed as "high", "medium" or "low".

When a crop or crop group is rated "high", conditions in the PPA are reported or inferred to be compatible with the known requirements of the crop or crop group.[2] In the case of single crops, it is necessary to generalize requirements as though all varieties were similar. In the case of crop groups, it is necessary to generalize for different species. When a crop or crop group is rated "medium", conditions in the PPA are reported or inferred to be marginal, in one or more ways, with respect to the known requirements of the crop or crop group. In the case of crop groups, conditions may be marginal for one or more crops in the group. It may be inferred that a "high" rating implies a possibility of yield comparable to the upper values reported in agronomic literature for a given level of management. Similarly, a "medium" rating may be interpreted to suggest that such high yields are unlikely to be obtained in the PPA. When a crop or crop group is rated low, conditions in the PPA are reported or inferred to be incompatible with several of the known requirements of the crop or a crop in the crop group. A "low" rating means that yields can be expected to be highly variable from year to year. In many instances in the detailed descriptions "low" ratings are provided to acknowledge that crops with highly variable yields are traditionally cultivated to some extent in the PPA.

The crop groups employed for the recommendations in Syria are:

1. small grains:	barley wheat (soft and hard)
2. fruit trees:	all woody perennials grown for fruit or nuts <u>except</u> olives, citrus, and grapes
a. rosaceous fruit trees:	almonds apples apricots cherries peaches
b. non-rosaceous fruit trees:	figs pistachios pomegranates
3. oil crops	peanuts sesame sunflower

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[1] Crops taken to be major crops are a matter of judgement. Other conventional food or fiber crops of minor importance may also be suited for specific PPAs.

[2] Crop requirements were suggested by material on file at the Economic Botany Laboratory, Science and Education Administration, U.S. Department of Agriculture.

4.	cotton	all species of <u>Gossypium</u> (Malvaceae) by implication, but keyed most to the requirements of <u>Gossypium herbaceum</u>
5.	pulses	chickpeas haricot beans lentils vetches
6.	tuber/bulb crops:	garlic onions potatoes sugar beets
7.	vegetables:	- cucurbits (melons, squash, snake cucumbers, etc.) - solanaceae crops (tomatoes, eggplants, etc.) - cauliflower - brassicaceae crops (other than the above, by implication) - okra
8.	olives	
9.	grapes	
10.	citrus	

These crop groups contain crops with similar requirements to the extent possible. However, a crop group is selected for a particular PPA with the knowledge that some heterogeneity in requirements exist within it and that final selection of specific crops will require additional information.

ATTACHMENT B-1: SOILS: LIST OF PRINCIPAL SOURCES

Muir, A. 1951. "Notes on the Soils of Syria." Journal of Soil Science, Vol. 2, No. 2, 20 p.

Mulders, M.A. 1969. The Arid Soils of the Balikh Basin (Syria). Rotterdam. 196 p.

Reifenberg, A. 1952. "The Soils of Syria and the Lebanon." Journal of Soil Science, Vol. 3, No. 1. 21 p.

Subramanian, V.S 1972. Report on the Soil Survey of Ghab Valley. Syrian Arab Republic, United Nations Development Programme, FAO; Ghab Development Project (Phase II) in cooperation with Ministry of Agriculture. Damascus. 37 p.

van Alphen, J.G. and G. de los Rios Romeros. 1971. Gypsiferous Soils. International Institute for Land Reclamation and Improvement. Wageningen, The Netherlands. 44 p.

van Liere, W. J., et al. 1968. Soil Map of Syria. 1:500,000. Five (5) sheets. WSRO/FAO.

van Liere, W.J. 19??. Soil Map of Syria. 1:200,000. Ten (10) sheets (WSRO/FAO?)

________ 1954. Soils of Syria. FAO. 8 p.

ATTACHMENT B-2: SOIL DATA COLLECTION FORM

AGRICULTURAL PRODUCTION POTENTIAL STUDY

General Soils Information

1. Map unit symbol:

2. Map unit name:

3. Composition of map unit (principal components and estimated proportion of the map unit represented by each):

   a. ____%

   b. ____%

   c. ____%

4. Underlying geologic and/or soil parent material:

5. Mean annual precipitation (including seasonality):

6. Mean annual temperature (including seasonality):

7. Terrain and landform:

   a. Local relief:

   b. Elevation (above sea level):

8. Native vegetation:

9. Current land use:

ESTIMATED SOIL PROPERTIES AND SPECIAL FEATURES

	Components of Map Unit #1	#2	#3
1. Slope (percent)			
2. Depth to bedrock (m)			
3. Soil texture			
4. Coarse fragments			
5. Permeability			
6. Reaction			
7. Salinity			
8. Available water capacity			
9. Flooding			
10. Soil drainage class			
11. Base saturation			
12. Other features			

ATTACHMENT B-3: SOIL DESCRIPTIONS

Brief descriptions of selected categories of Soil Taxonomy are provided here for the convenience of those users of Volume 2: Natural Resource Annex who are not familiar with Soil Taxonomy. The classification of the soils of Syria was based on soil maps and other information made available by SARG for use in compiling a general soil map used in the development of resource planning units for the country. The meager supporting data available was insufficient to accurately place soils in the precisely defined categories of Soil Taxonomy. Therefore, in many instances, classification was accomplished by inferring soil characteristics common to similar soils in analagous areas.

The descriptions which follow are based on specific criteria set forth in Soil Taxonomy and should be considered type descriptions for the respective categories; they do not necessarily reflect data obtained by field observations made in Syria or laboratory analyses of soil samples taken in Syria.

ALFISOLS

Characteristics of Alfisols are A horizons that have lost silicate clay, sesquioxides, and bases and B horizons that have accumulations of silicate clay (argillic or natric horizons) and have moderate to high levels of exchangeable calcium and magnesium.

XERALFS

These are the well-drained Alfisols of temperate regions with cool season rainfall. Mean annual soil temperatures are between 8 and 22^{o}C. Rainfall during the cool season is enough so that some water passes through the soils in many years. Xeralfs are dry in all parts of their profiles for at least 45 consecutive days during the growing season.

Xeralf profiles characteristically have ochric epipedons (rather pale but not white A horizons), reddish or brownish argillic horizons (B horizons of silicate clay accumulation), and paler C horizons. Additional horizons are present in some profiles.

Rhodoxeralfs. These Xeralfs have fairly uniform dark red colors throughout their profiles. The soils have been formed from basic rocks such as basalt and limestone.

ARIDISOLS

Aridisols have extended periods of time in which the soils contain little or no moisture in forms available to plants, one or more evident horizons, thin and rather pale surface horizons with slight accumulations of humus (ochric epipedons), and a soil surface without wide cracks at any time. All Aridisols are low in organic matter and have relatively pale colors. Most have accumulations of calcium carbonate at some depth within the profile.

ORTHIDS

All orthids have pale surface horizons (ochric epipedons) and one or more subsurface horizons other than B horizons marked by silicate clay accumulation. Such subsurface horizons extend to depths of 25 cm or more.

Calciorthids. These Orthids have calcic horizons (subsurface layers greatly enriched in carbonates) and are usually moderate to high in calcium carbonate throughout their profiles. The soils are pale in color because of carbonates.

Camborthids. These Orthids have cambic horizons that are brownish or reddish in color and brighter than overlying and underlying horizons. They have ochric epipedons (light-colored A horizons) and usually have accumulations of carbonates below their cambic horizons.

Gypsiorthids. These Orthids have gypsic horizons (subsurface layers enriched in gypsum) within 1 m of the soil surface and pale in color throughout.

Paleorthids. These Orthids have petrocalcic horizons (carbonate-cemented subsurface layers) within 1 m of the soil surface.

ENTISOLS

These soils have faint or few horizons. Many have ochric epipedons (pale but not white surface layers) and have some albic horizons (white layers near the surface), but these are thin enough so that they would be destroyed by plowing.

ORTHENTS

Orthents may have faint or thin A horizons but most have C horizons at the surface. Landforms are dominantly hilly or steep but include some gentle slopes. Moisture regimes and temperature regimes have wide ranges.

Torriorthents. These are the driest soils of the Orthents being dry most of the year. Such soils are associated with Aridisols. The profiles are dry in all parts most of the year and are never moist in all parts for 90 consecutive days.

Xerorthents. These Orthents are found in regions with winter rainfall. The soils are dry for 45 or more consecutive days during the warm season.

FLUVENTS

These are well and moderately well-drained Entisols in recent alluvium, much of which has accumulated during the last few centuries. Such soils are in flood plains still subject to active deposition but not subject to ponded water. Soil colors are mostly shades of brown. Profiles have textures of sandy loam or finer in major shares of the uppermost 1 m (40 inches). Distribution of organic carbon is irregular in the profiles. Moisture regimes have a wide range. Such soils may be saturated briefly but not for long. At the other extreme are Fluvents which are dry nearly all the time. Mean annual soil temperatures also have a wide range, all above $0^{\circ}C$.

Torrifluvents. These Fluvents are dry most of the time, associated as they are with Aridisols. Torrifluvent profiles are dry in all or most parts more than half of the year and never moist in all parts for 90 consecutive days.

Xerofluvents. These Fluvents occur in regions with winter rainfall. The profiles are dry in all parts for 45 or more consecutive days during that growing season.

INCEPTISOLS

Characteristics of Inceptisols are few or faint horizons, good to fair moisture regimes, some weatherable minerals, textures finer than loamy fine sand, and clay fractions with moderate to high activity. Many but not all of them have subsurface horizons of alteration and loss known as cambic horizons.

AQUEPTS

These are wet Inceptisols, found mostly on flats and in low places. Water is present in the soils most of the time. Because of the wetness, the deeper profiles are gray with or without mottles. The gray subsurface horizons are considered cambic horizons because of alterations due to wetness and associated weathering. Many Aquepts have dark A horizons a few centimeters thick, but such horizons reach a thickness of 30 cm (12 inches) in some great groups.

Halaquepts. These Aquepts have appreciable quantities of exchangeable sodium and could be considered sodic soils. Some are saline as well. Mean annual soil temperatures are above $0^{\circ}C$.

Haplaquepts. These Aquepts could be considered type-specimens for the suborder. They have the gray cambic horizons but no extra horizons or other features. Most are in middle latitudes. Mean annual soil temperatures are above $0^{\circ}C$ and differences between mean temperatures of warm and cool seasons are $5^{\circ}C$ ($9^{\circ}F$) or more.

OCHREPTS

These soils characteristically have ochric epipedons (pale but not white A horizons) over brownish cambic horizons. Enough water is present to permit some leaching of the driest Ochrepts, whereas substantial leaching prevails in those of the most humid regions.

Xerochrepts. These Ochrepts occur in regions with rainfall restricted to the cool season. Soil profiles are dry in all parts for 45 or more consecutive days during the growing season. The soils are moderate to high in bases such as calcium but relatively low in organic matter.

VERTISOLS

Commonly Vertisols have high amounts of active clay, low levels of organic matter, dull colors, extended periods with little moisture, and marked swelling and shrinking with wetting and drying. During some time each year, cracks several centimeters (2.5 cm or more) across are present either at the soil surface or at the bottom of a plow layer. Because of the swelling, shrinking, and cracking, Vertisols are slowly but continuously being mixed from top to bottom and have therefore been called "self-swallowing soils."

XERERTS

These Vertisols occur in regions with warm, dry summers and cool, wet winters. Cracks form in the soils every year and remain open for more than two months during the latter part of the warm, dry season. The suborder consists of two great groups.

Chromoxererts. These Xererts have gray or grayish brown A horizons, very little if any darker than the deeper profiles.

Pelloxererts. These Xererts have black, very dark gray, or very dark grayish brown A horizons appreciably darker than the deeper profiles.

Six modifying descriptors precede the names of the great groups described above:

aeric - used with names of soils that are wet much of the year; indicates either a shorter period of saturation or somewhat deeper ground water than that in soils described as typic.

aquic - indicates presence of ground water near the surface at some time during the year.

calcic - used with Gypsiorthids to indicate presence of a layer of calcium and/or magnesium carbonate above the gypsium layer.

lithic - indicates soil depth of less than 50 cm to bedrock.

petrogypsic - used with Gypsiorthids to indicate presence of a gypsum cemented layer which is impenetrable by roots and will not slake in water.

typic - indicates the central concept of the group.

vertic - indicates clayey textures and presence of deep wide cracks when the soil is dry.

xeric - soils are moist more than one-fourth of the time when soil temperature at a depth of 50 cm is $5^{o}C$ or higher; in areas of winter precipitation intermediate between that common for a Mediterranean climate and that of a desert.

ATTACHMENT B-4: MAP AND MAP FILE CODES FOR THE SOILS MAP. (cont'd.)

Numeric Code Used in the Computer Map File	Legend Symbol on the 1:500,000 Display Maps	Description
21	DOLe L/LS	Lithic Calciorthids and associated soils from limestone on level plains.
22	DOLe R/LS	Lithic Calciorthids and associated soils from limestone on rolling plains.
23	DOLe U/LS	Lithic Calciorthids and associated soils from limestone on undulating plains.
24	DOPa L/LS	Typic Paleorthids and associated soils from limestone on level plains.
25	DOPa U/LS	Typic Paleorthids and associated soils from limestone on undulating plains.
26	EFHg L/A	Xeric Torrifluvents and associated soils from alluvium on level plains.
27	EFXa L/A	Typic Xerofluvents and associated soils from alluvium on level plains.
28	EOHa L/L	Typic Torriorthents and associated soils from loess on level to gently sloping plains.
29	EOHa L/U	Typic Torriorthents and associated soils from unconsolidated materials on level to undulating plains.
30	EOHa U/U	Typic Torriorthents and associated soils from unconsolidated materials on undulating plains.
31	EOHc H/B	Lithic Torriorthents and associated soils from basalt on hilly topography.

Continued

ATTACHMENT B-4: MAP AND MAP FILE CODES FOR THE SOILS MAP. (cont'd.)

Numeric Code Used in the Computer Map File	Legend Symbol on the 1:500,000 Display Maps	Description
32	EOHc H/LS	Lithic Torriorthents and associated soils from limestone on hilly topography.
33	EOHc HD/LS	Lithic Torriorthents and associated soils from limestone on maturely dissected plains.
34	EOHc L/B	Lithic Torriorthents and associated soils from basalt level to undulating plains.
35	EOHc R/B	Lithic Torriorthents and associated soils from basalt on rolling plains.
36	EOHc U/B	Lithic Torriorthents and associated soils from basalt on undulating plains.
37	EOHk L/U	Xeric Torriorthents and associated soils from unconsolidated materials on level plains.
38	EOHk R/U	Xeric Torriorthents and associated soils from unconsolidated materials on rolling plains.
39	EOHk U/U	Xeric Torriorthents and associated soils from unconsolidated materials on undulating plains.
40	EOXa L/U	Typic Xerorthents and associated soils from unconsolidated materials on level plains.
41	EOXd H/CH	Lithic Xerorthents and associated soils from marl on hilly topography.
42	EOXd L/LS	Lithic Xerorthents and associated soils from limestone on level plains.

Continued

ATTACHMENT B-4: MAP AND MAP FILE CODES FOR THE SOILS MAP. (cont'd.)

Numeric Code Used in the Computer Map File	Legend Symbol on the 1:500,000 Display Maps	Description
43	EOXd R/B	Lithic Xerorthents and associated soils from basalt on rolling plains.
44	EOXd S/B	Lithic Xerorthents and associated soils from basalt on steep hills.
45	EOXv L/LS	Xerorthents, lithic vertic phase and associated soils from limestone on level to undulating plains.
46	EOXv R/LS	Xerorthents, lithic vertic phase and associated soils from limestone on rolling plains.
47	EOXv U/LS	Xerorthents, lithic vertic phase and associated soils from limestone on undulating plains.
48	EOXv R/B	Xerorthents, lithic vertic phase and associated soils from basalt on rolling topography.
49	EOXv H/LS	Xerorthents, lithic vertic phase and associated soils from limestone on hilly topography.
50	EOXv U/B	Xerorthents, lithic vertic phase and associated soils from basalt on undulating plains.
51	IAHa L/U	Typic Haplaquepts and associated soils from unconsolidated materials on level plains.
52	IAHb L/A	Aeric Haplaquepts and associated soils from alluvium on level plains.

Continued

ATTACHMENT B-4: MAP AND MAP FILE CODES FOR THE SOILS MAP. (cont'd.)

Numeric Code Used in the Computer Map File	Legend Symbol on the 1:500,000 Display Maps	Description
53	IAHb L/CH	Aeric Haplaquepts and associated soils from marl on level plains.
54	IAHb L/D	Aeric Haplaquepts and associated soils from colluvium on level plains.
55	IASa L/A	Typic Halaquepts and associated soils from alluvium on level plains.
56	IASb L/A	Aeric Halaquepts and associated soils from alluvium on level plains.
57	IOXa L/U	Typic Xerochrepts and associated soils from unconsolidated materials on level plains.
58	IOXa R/U	Typic Xerochrepts and associated soils from unconsolidated materials on rolling plains.
59	IOXh H/TS	Lithic Xerochrepts and associated soils from weakly consolidated materials on hilly topography.
60	IOXh R/LS	Lithic Xerochrepts and associated soils from limestone on rolling plains.
61	IOXh S/B	Lithic Xerochrepts and associated soils from basalt on steep hills.
62	IOXh S/CH	Lithic Xerochrepts and associated soils from marl on steep hills.
63	IOXh S/LS	Lithic Xerochrepts and associated soils from limestone on steep hills.

Continued

ATTACHMENT B-4: MAP AND MAP FILE CODES FOR THE SOILS MAP. (cont'd.)

Numeric Code Used in the Computer Map File	Legend Symbol on the 1:500,000 Display Maps	Description
64	IOXh U/LS	Lithic Xerochrepts and associated soils from limestone on undulating plains.
65	IOXk L/U	Vertic Xerochrepts and associated soils from unconsolidated materials on level plains.
66	IOXk R/U	Vertic Xerochrepts and associated soils from unconsolidated materials on rolling plains.
67	IOXk U/U	Vertic Xerochrepts and associated soils from unconsolidated materials on undulating plains.
68	VXCa L/LS	Typic Chromoxererts and associated soils from limestone on level plains.
69	VXCa L/U	Typic Chromoxererts and associated soils from unconsolidated materials on level plains.
70	VXCa R/B	Typic Chromoxererts and associated soils from basalt on rolling plains.
71	VXCa U/B	Typic Chromoxererts and associated soils from basalt on undulating plans.
72	VXCa U/LS	Typic Chromoxererts and associated soils from limestone on undulating plains.
73	VXPa L/SD	Typic Pelloxererts and associated soils from calcareous sandstone on level plains.
74	VXPa R/B	Typic Pelloxererts and associated soils from basalt on rolling plains.

Continued

ATTACHMENT B-4: MAP AND MAP FILE CODES FOR THE SOILS MAP. (cont'd.)

Numeric Code Used in the Computer Map File	Legend Symbol on the 1:500,000 Display Maps	Description
75	VXPa U/B	Typic Pelloxererts and associated soils from basalt on undulating plains.
76	DOLe HD/LS	Lithic Calciorthids and associated soils from limestone on maturely dissected plains.
77	EOXd U/B	Lithic Xerorthents and associated soils from basalt on undulating plains.
78	EOHc S/LS	Lithic Torriorthents and associated soils from limestone on steep hills.
79	VXCa L/B	Typic Chromoxererts and associated soils from basalt on level plains.
80	EOXd R/U	Lithic Xerorthents and associated soils from basalt on rolling topography.
81	DOPa HD/LS	Typic Paleorthids and associated soils from limestone on maturely dissected plains.

ATTACHMENT C-1: CROP CLIMATE: LIST OF PRINCIPAL SOURCES

BOOKS

Agroclimatological Reference Book for the Syrian Arab Republic. Ministry of Defense, Damascus, 19??.

Climatic Atlas of Syria. Ministry of Defense, Damascus, 1977.

Davis, P.H. Flora of Turkey. Edinburgh, 1965.

Good, R., M.A. The Geography of the Flowering Plants. Longman, London, 1971.

Kulik, M.S. and Sinelshchikod, B.B. Lektsii po Selskokhozyaistvennoi Meteorologii. Leningrad, 1966.

Mouterde, P. La Flore du Djebel Druze. Beirut, 1953.

Mouterde, P. Nouvelle Flore du Liban et de la Syrie. 1966.

Nyrop, R.F. Area Handbook for Syria. U.S. Government Printing Office, 1974.

Papadakis, J. Climates of the World and their Agricultural Potentialities. Buenos Aires, 1966.

Post, G.E. Flora of Syria, Palestine and Sinai. Beirut, 1932-33.

Rechinger, K. Flora of Lowland Iraq. Weinheim, 1964.

Syrian Arab Republic, Ministry of Agriculture and Agrarian Reform, Directorate of Land Reclamation. "National Agricultural Patterns for the Most Important Regions of Syria". The original Arabic citation (available upon request) was undated. The material included Arabic-Latin lists of plants found in regions of Syria.

Zohary, M. Flora Palaestina. Jerusalem, 1966.

MAPS

Syrian Arab Republic, Ministry of Agriculture, Directorate of Land Reclamation, Floristic Map. This map was undated but believed to have accompanied "National Agricultural Patterns for the Most Important Regions of Syria."

ATTACHMENT C-2: DESCRIPTION OF SYRIAN CROP-CLIMATE MAP ZONES

Generalized Crop-Climate Zones	Average Annual Precipitation (mm)	Average Annual Temperature (°C)	Average Absolute Minimum Temperature (°C)	Average Absolute Maximum Temperature (°C)	Average Minimum Temperature of the Coldest Month (°C)
1	600 to 700	14 to 16	-6 to -5	41 to 42	0
2	500 to 750	15 to 18	-5 to -3	41 to 44	1 to 5
3	300 to 500	16 to 18	-8 to -3	42 to 49	0 to 4
4	> 750	14 to 18	-6 to +2	35 to 41	0 to 10
5 1/	300 to 1000	16 to 18	-5 to -2	41 to 45	3 to 6
6	> 750	18 to 20	-2 to +4	38 to 41	6 to 10
7 2/	150 to 250	8 to 18	-10 to -3	34 to 35	2 to 4
8	500 to 800	12 to 14	-10 to -6	34 to 36	0 to 1
9	350 to 500	8 to 12	-10 to -8	34 to 40	-3 to -2
10	250 to 400	12 to 14	-8 to -5	36 to 42	-2 to +1
11 3/	400 to 1000	12 to 18	-5 to -1	36 to 42	0 to 5
12 4/	350 to 800	17 to 20	-4 to +2	38 to 43	4 to 7
13 5/	200 to 500	10 to 16	-8 to -3	40 to 43	-2 to +4
14 6/	100 to 300	14 to 21	-8 to -3	40 to 49	0 to 5
15 7/	250 to 300	18 to 19	-6 to -4	46 to 49	2 to 3
16 8/	400 to 500	17 to 19	-6 to -3	45 to 48	1 to 4
17	500 to 600	18 to 20	-5 to -3	44 to 45	3 to 4
18	> 600	19 to 20	-4 to -3	44 to 45	3 to 4

1/ Crop climate zone 5 overlaps zones 2 and 3 with respect to these parameters, but zone 5 has a less intense wet season. Crop climate zone 5 also overlaps zones 11 and 12 (see parameters of zones 11 and 12).

2/ In crop climate zone 7 the agriculturally-limited mountains in the western part were included as a matter of convenience, but were not reflected in these parameters.

3/ Crop climate zone 11 overlaps zones 2, 3, 5, and 12 with regard to these parameters, but differs with regard to floristic composition to an extent which suggested differences in climate sufficient to merit recognition as a separate zone.

4/ Crop climate zone 12 overlaps zones 2, 4, 5, 6, and 11 with respect to these parameters, but differs with regard to floristic composition to an extent which suggested differences in climate sufficient to merit recognition as a separate zone.

5/ Crop climate zone 13 overlaps zones 10 and 14 with regard to these parameters, but differs with regard to floristic composition to an extent which suggested differences in climate sufficient to merit recognition as a separate zone.

6/ Crop climate zone 14 overlaps 15 with regard to these parameters. However, the wet season is less intense in zone 14 than in zone 15. Zone 14 also overlaps zone 13 (see parameters of zone 13).

7/ See footnote 6, above.

8/ Crop climate zone 16 overlaps zone 3 with regard to these parameters, but the wet season is less intense in zone 3 than zone 16, and differences in floristic composition suggested differences in climate sufficient to merit recognition as a separate unit.

Appendix 2

Computer Mapping

A. Introduction

As one of the two information subsystems designed to analyze the Syrian agricultural land resource base, the Land Information Subsystem (LIS) provides the capacity for the spatial identification of the extent of agricultural resources and certain uses of these resources so that this information can be geocoded from maps, assembled, stored, and retrieved for purposes of information integration, interpretation, statistical summarization, and graphic display.

This appendix details the procedures of the map coding component of the Land Information Subsystem used to code the various maps on agricultural resources and for resource use. It also describes the major features of the map processing component of the Land Information Subsystem used to add information base and display statistical and/or graphic summaries of desired information. A description of the maps geocoded and scale of geocoding for all maps in the Syrian Land Information Subsystem are also included.

B. Map Coding Process

Map data are generally coded using one of two basic approaches: 1) digitizing the boundaries of the map units thus creating a file describing map boundary locations and an identifier code for each discrete map unit, or recording the occurrence of a dominant feature within a grid cell. The grid geocoding method has been adopted by the CRIES project staff because of its simplicity and relatively low costs for data generation combined with the capability to reproduce area totals with acceptable levels of accuracy. However, depending on availability of participating country equipment such as digitizers and plotters, the geocoding process can be automated.

The objective of the map coding process is to create a computer file suitable for use in the computer mapping system. A schematic of the overall process (Figure 1) illustrates the major steps in the process and will be discussed in more detail in the following sections.

The process begins with a map or a collection of maps which are to form the data base. Each map is processed so that the boundary and legend (identifier code) for each map unit are written onto a set of coding forms. This is a manual procedure performed by a two-person coding team. The technical details of the procedures used to code the Syrian maps varied with the scale and complexity of the map materials.

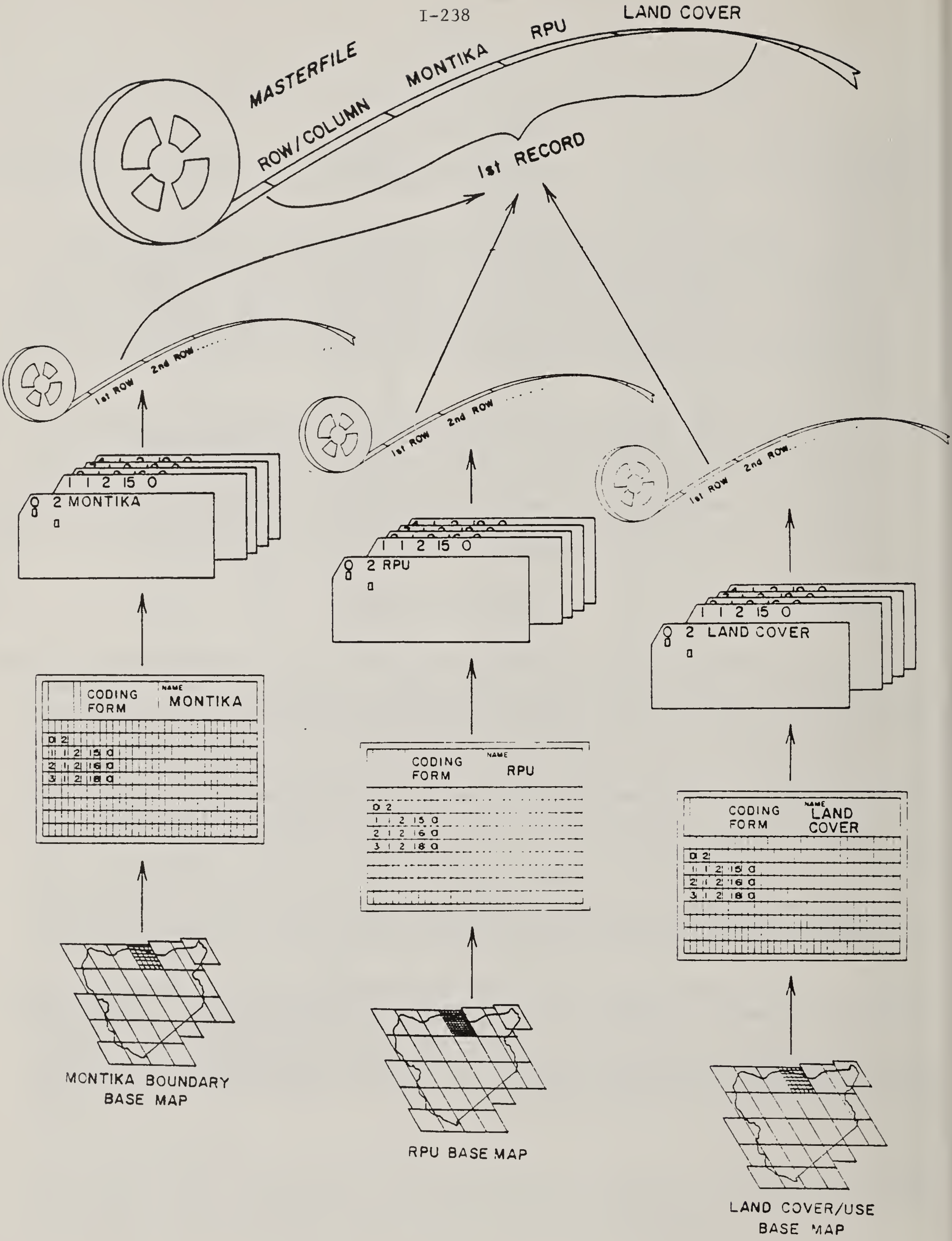


Figure 1.--Schematic illustration of creating a computer file of information from mapped data.

Once the coding forms are completed, they are keypunched onto computer cards. A computer program is then used to verify that the map is coded correctly. The verification also includes comparing the outside boundaries of the map to a standard map (usually the administrative boundaries map) in order to ensure that the total land areas of all maps in the system match.

Once map verification is completed, the final step is to place the fully corrected map onto the permanent Master File stored either on a magnetic tape or computer disk.

Geographic Referencing

Grid referencing is the first step in preparing maps for geocoding. It is the grid referencing system which ties the thematic information portrayed on a map to its actual location on the ground. A grid referencing system based on the UTM grid (Universal Transverse Mercator - an international earth coordinate system found on most base maps) is used by the CRIES project staff to provide this structure within which it is then possible to accurately assign a unique spatial identification code to each grid cell. For Syria, a "window" of the UTM grid was created 585 kilometers in the north-south direction and 620 kilometers in the east-west direction. This window was divided into a grid of regularly spaced rows and columns (Figure 2). Lines were drawn on the map at 100 km intervals and were used to register an acetate grid in the coding process. The cell size appropriate for national-level studies depends on the available map data and study objectives.

Each grid cell has a unique address created by assigning a row-column coordinate to the southeast corner of each cell. The notation is similar to that used in analytical plane geometry with row numbers increasing from north to south and column numbers increasing from west to east (or to standard two-dimensional matrix notation). The cell address is always written as a coordinate pair with the row coordinate first. Map data are recorded by assigning to each grid cell a number code representing a single unique map unit. The process of converting an irregularly shaped map unit into a gridded format and how the data would look if reconstructed by the computer is illustrated (Figure 3).

Map Coding

The Syrian maps that were available for processing were at several scales; and geocode efficiently two methods were employed. For the maps at a scale of 1:200,000 a properly scaled clear acetate grid with a 1 km grid cell size was placed over the map aligning the edges of the grid to the 100 km grid lines previously drawn on the map. Cells which contain a mapping unit boundary are usually assigned a single code based on the dominant mapping unit within that cell. Inevitably this generalizes the boundaries; however, the error in area

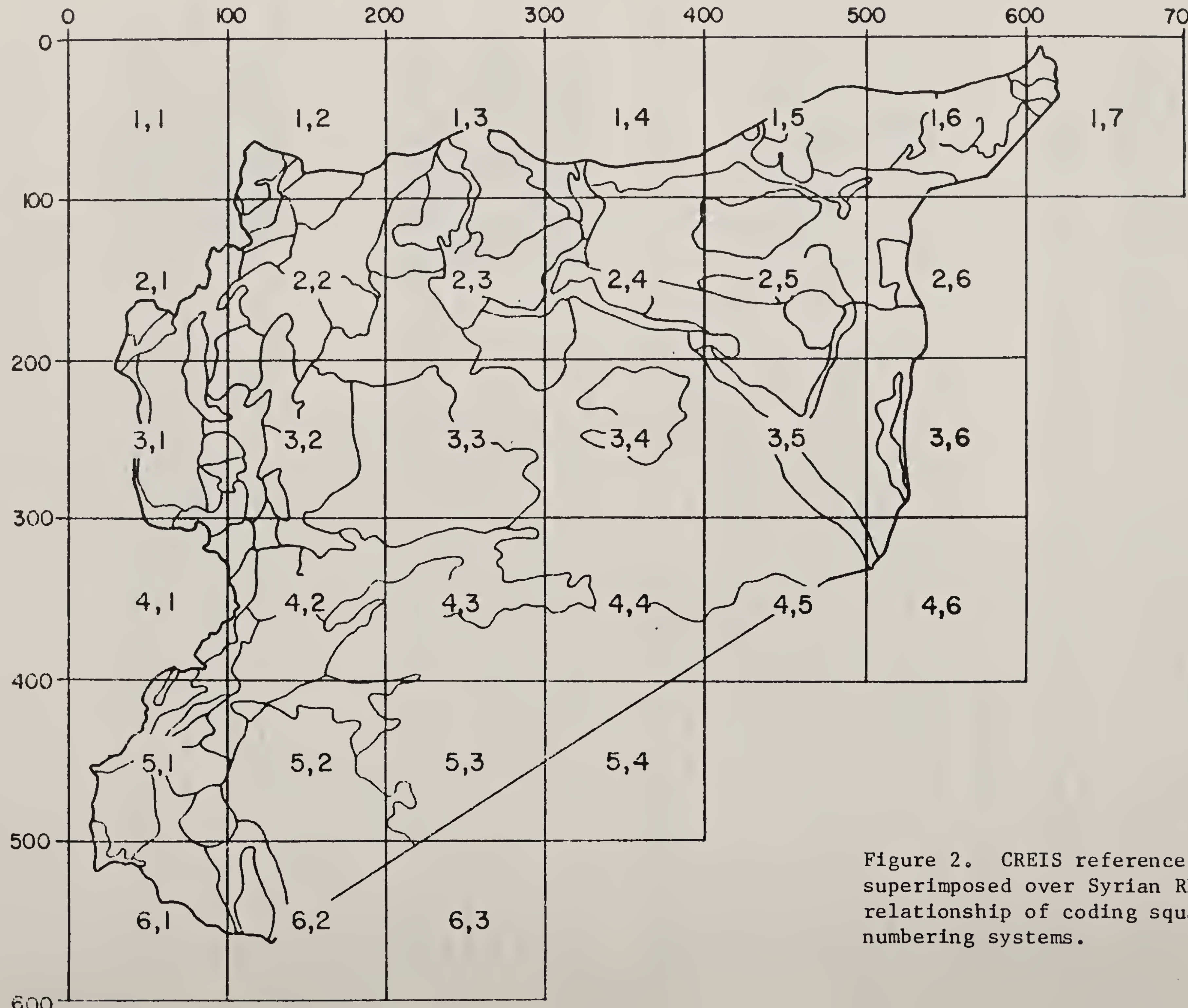


Figure 2. CREIS reference grid system superimposed over Syrian RPU map. Note relationship of coding squares and line numbering systems.

Figure 3. Irregular shaped map units can be represented by a system of grid cells. A: Map units on the original map. B: Each map unit is assigned a zero code. C: Map units are approximated by a system of grid cells, each cell containing the code of the underlying map unit. D: Map units reconstructed by a computer.

statistics derived using this method is small. However, when the mapped distribution is comprised of many small scattered units, a data recording system is used so that data can be recorded as that unit which is found under a point in the center of the 1 km grid square. This is a sampling method that allows small areas which have a lower probability of dominating a cell than larger areas to have an increased probability of being recorded. The Preliminary Syria Land Cover/Use Map was geocoded using this point sampling method so as not to seriously overestimate or underestimate small areas in intensive agriculture.

A two-man coding team is used; one person reads the row-column coordinates and data from the map while the other person records the information on the coding forms. The acetate grid is scanned systematically beginning in the upper left corner and working across each row then repeating the process for each successive row. In actual practice, only those cells which contain a map boundary are recorded (Figure 4). This technique compresses the number of entries on the coding forms by eliminating all entries for grid cells between map boundaries (which is duplicate information from the preceeding map cell). This compression step substantially reduces the time required to code the maps. The compression rates depend principally on the complexity of the map, i.e., the less complicated, the higher the compression rate.

A different coding arrangement is used for the maps at 1:750,000 scale. At this scale it is possible to work with a map that contains all of Syria on one map sheet, and this in turn means that data can be collected from a map in a complete east-west swath rather than by 100 km^2 blocks. This method avoids changing maps and repositioning of the coding squares which makes for a more time-efficient process and eliminates an area where errors can easily occur. In practice, the creation of an actual grid is avoided. A measuring scale with units which equal the dimensions of the cell size at that particular map scale is created. The map to be geocoded is drafted (Figure 5, A and B) between two of these measuring scales formatted to a UTM coordinate system. A third measuring scale is created for the horizontal rule (Figure 5, C) and between these three scales, it is possible to re-create the grid. Geocoding proceeds in the manner described for the acetate coding square but takes a complete west-to-east scan of the country at one time. Then the horizontal rule is moved down one step to the next line. It would be possible to create a complete grid but since the map scale (1:750,000) is small, the measurement that represents 1 km is also small and complete grid at this size would be difficult to work with and possibly obscure some of the map detail. In these instances, a cell size of 2 km was used.

Data Verification

The coding forms prepared by the coding teams are key-punched and verified to record the data in machine-readable form as input to the geographic data file. Several verification steps are necessary before the file is accepted as correct. Initially a computer program scans the card deck and lists coding errors while checking for proper row-column sequencing and formatting

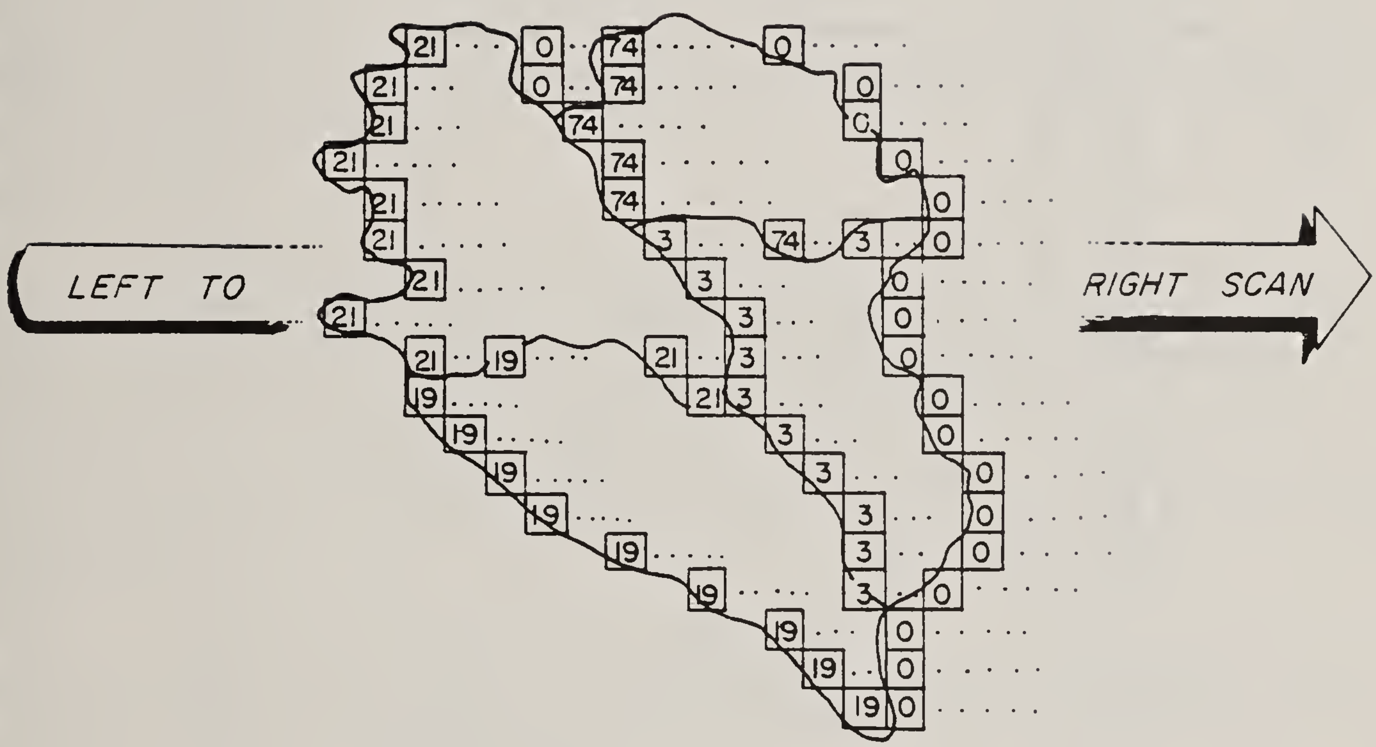


Figure 4.--Illustration of record of cells with boundary changes.

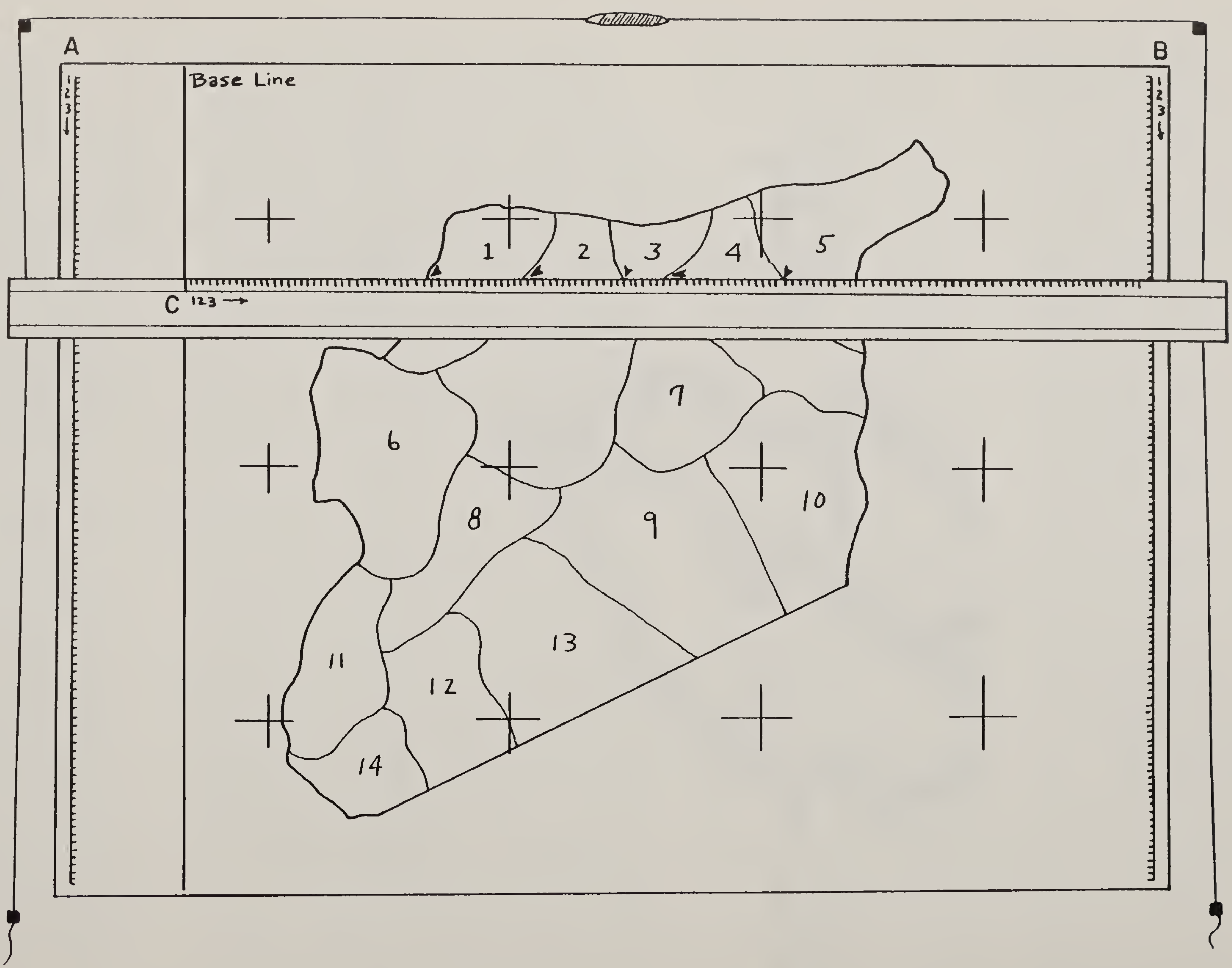


Figure 5.--Map at a processing scale of 1:750,000 wre geocoded using a movable horizontal scale, such as illustrated above. Vertical scales drawn on the map (A and B) were used to register the horizontal scale (C) to each grid row. The unit distance on all scales was 2 km.

of the data entries. After errors from this check are corrected it is then possible to produce an unscaled map for visual comparison with the original map. This map is elongated in the north-south direction as the shape of the computer printer symbol is not the square shape that it represents. Despite its shape, this product is adequate for the second level of checking which focuses on the accuracy of the internal border information. Errors identified are corrected interactively with the computer directly onto the map file. In addition to this internal verification, the map file is also checked against a standard map to establish calibration with official published areas and to define precisely the extent of the outside country borders. The computer program which performs this task lists all instances where the map border being checked does not coincide with the standard map border and these discrepancies are corrected.

Master File

Once an individual map file has been completely corrected and verified, it is merged into the Master File which contains the other maps in the system. A computer program is used to convert the format of the data from that recorded on the coding form which has data from one map with more than one boundary per record to a format which theoretically has an individual record for each grid cell, and a code for each of the maps in the system. In fact, because the information can be compressed in a manner described earlier in this report, the Master File contains a record of only those cells which contain a map boundary.

Any geocoded map can be included in the Master File. Maps incorporated can contain a data code for every grid cell in the country (such as land cover/use or soils) or there can be maps that depict the distribution of discontinuous features such as irrigation areas.

Resources Recquired for Map Coding

The map coding process outlined in this report emphasizes the use of manual teams in the data capture and verification stages. Usually a two-person team is sufficient to conduct all activities involved in map coding and verification. Occasional support assistance may be required in the key-punching and program operative steps. Map preparation will involve some limited cartographic support for transferring grid lines, changing map scales and similar graphic tasks. Hardware requirements are limited to those associated with a basic operating computer facility.

C. Computer Processing of Mapped Information

The map processing component of the Land Information Subsystem (LIS) provides the capability to make information taken from mapped materials available to analyst conducting technical and economic evaluations of agricultural and their current and/or potential uses. The map processing component

of LIS provides the ability to retrieve either all or portions of the geographic inventory of agricultural resource and use maps, to add new data to the information base, and to display the results in either statistical summaries or in map for. Typical products from the map processing component of LIS include area measurements for single maps (e.g. land cover/use totals by category for the country), area measurements of a combination of two or more maps (e.g. the distribution of land cover/use categories by administrative units), and computer-produced maps of various scales of single or combined map data.

How the Map Processing Component Works

The map processing component of LIS has two major parts: 1. the data file containing the digital map information; and 2. the computer software that performs the various mapping and analytical tasks on this data file.

The map data file is a record of the maps that have been geocoded (Figure 6). It represents an approximation of the continuous features defined on those maps as an accumulation of discrete units or cells. The individual cells record the boundaries of map units and the occurrence of a dominant feature within a grid cell and can be reconstructed to create a digital version of a particular map.

The computer software consists of a series of program phases which operate on a mutually compatible internal data file (Work File) which is a working copy of the Master File. Each program phase (Table 1) performs a specific operation on the data. All of the maps contained in the Master File are available for use, either singly or in combination.

Phases of the Map Processing Component

The ten phases of the mapping system and their functions are summarized (Table 1) and a schematic of the program's operation is illustrated (Figure 7). The DELETE, END, LIST, NEWFILE and WORKFILE phases provide basic data retrieval, file editing and program control. The CROSSTABS phase is used to produce a cross-tabulation frequency matrix for one to three variables read from the map files. GROUP is used to combine individual map codes into specific ranges and assigns each range an identifying code. This phase is normally used in order to place more than one variable into a single category prior to mapping or cross-tabulation. The NEWFILE phase writes a new map file and is used in order to save data created during a computing session or to create a new data set for a user-defined area specified through the WINDOW phase. Computer printer maps at variables scales using a specified set of print characters and/or overprints can be produced using the PRINTERMAP phase. SORT permits the user to identify specific concurrence of map codes from one to three different maps.

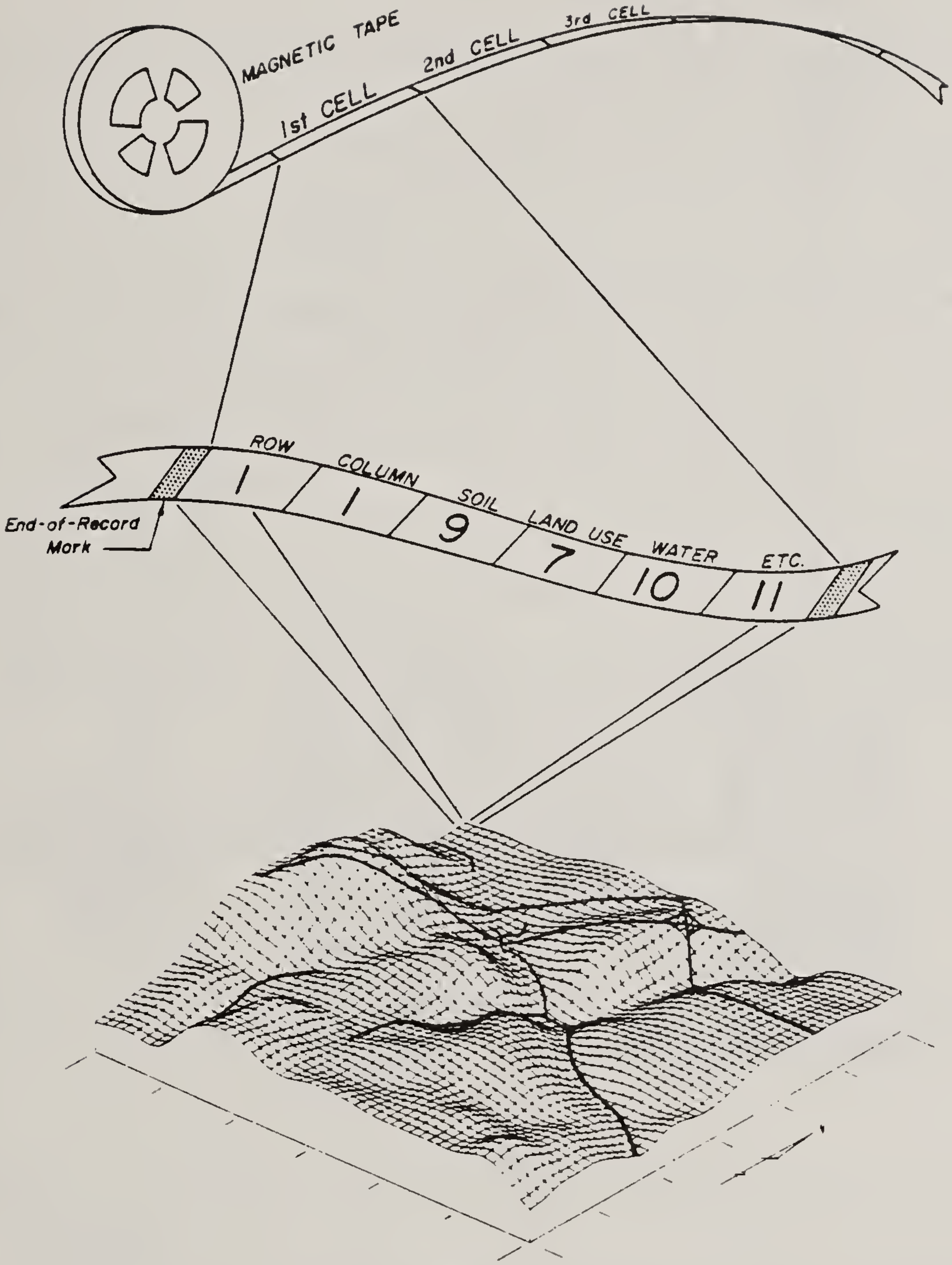


Figure 6.--For each grid cell, the row-column coordinate and various map codes are recorded sequentially on magnetic tape, disk, or computer cards.

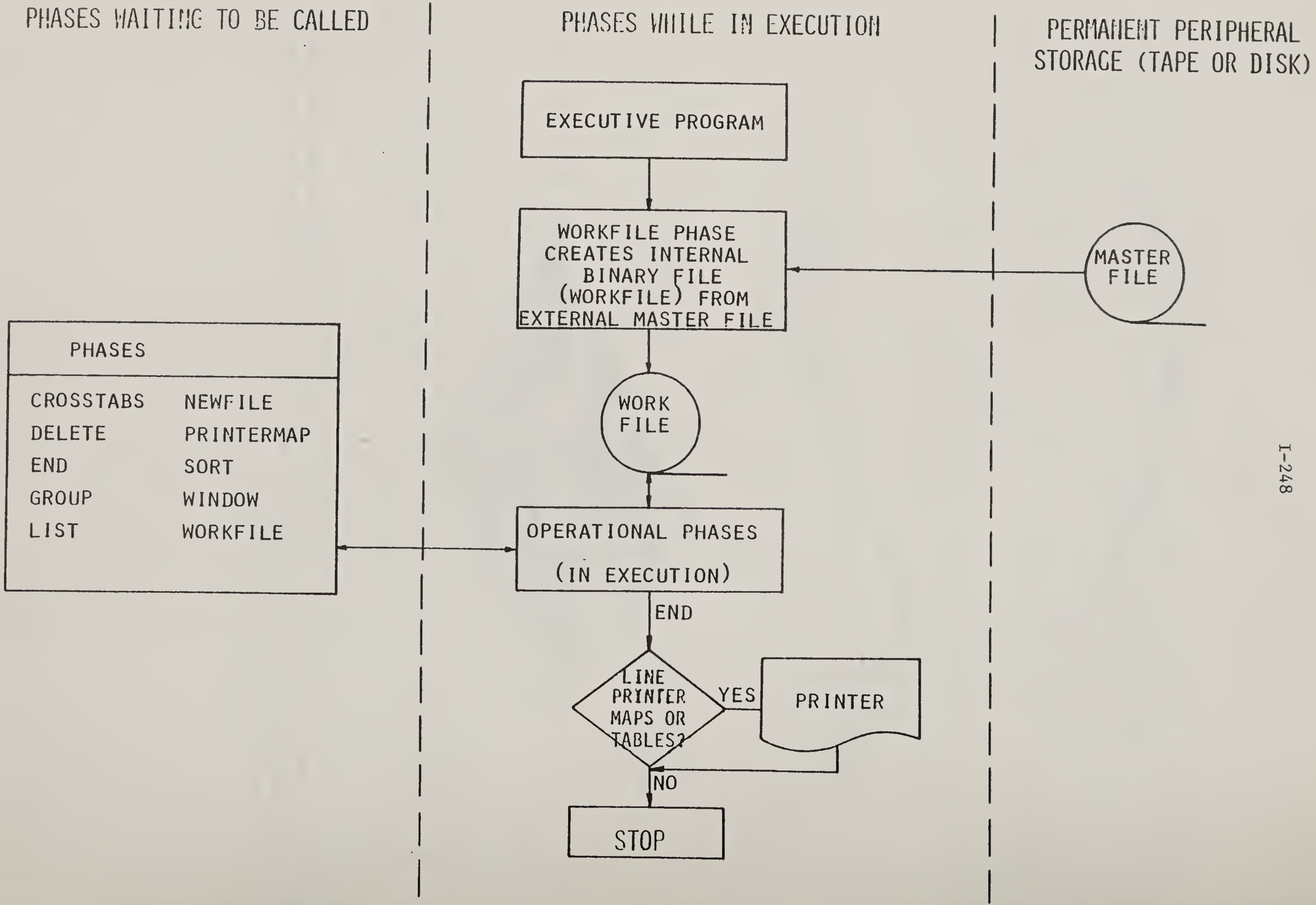


Figure 7.--Schematic diagram of the LIS map processing component.

Table 1.--Phases of the LIS Map Processing Component.

Phase	Function
CROSSTABS	Generates 1- to 3-way cross-tabulation table.
DELETE	Deletes a map from the Work File.
END	Stops execution of the program.
GROUP	Groups map codes into ranges.
LIST	Lists current attributes of file.
NEWFILE	Writes a new map file for updating.
PRINTERMAP	Constructs variable scale, single or multi-character symbol maps using high-speed line printer.
SORT	Assigns identifying codes for 1- to 3-way match of map codes.
WINDOW	Extracts a new map file based on a subset of the old map file.
WORKFILE	Retrieves maps from the map file and creates internal working file.

Products

CROSSTABS

The CROSSTABS phase of the CRIES mapping system produces a cross-tabulation frequency matrix for up to a maximum of three variables. In addition to the frequency count, row percent, column percent and percent of the grand total are printed for each matrix cell.

Identification of Combined Data

The mapping system permits several ways to identify groups or specific combinations of data. When operating on one map, the user may call into use the GROUP phase. The map data may then be grouped into categories defined by the user. As an example, intensive and extensive agricultural categories from the land cover/use file have been combined to display the total area of cropped land (Figure 8).

Another method of identifying combinations of data from one or more maps is available through the SORT phase. A typical example of the use of this phase would be to identify a particular land cover/use-soil type combination. Once identified, this combination can be assigned an identifying code which can be used in the mapping phase or in the CROSSTABS phase to determine the area and percentages of the combined data.

Program Mapping

The PRINTERMAP phase is a variable scale mapping program that uses the computer's high-speed line printer as a display device. Using this phase, maps of single or combined data can be developed by the system. These graphics aid in analytical work and also in the communication of planning concepts.

A feature of the PRINTERMAP phase permits scaling of the map to its true proportions and to any size. This feature is useful in displaying final analytical maps, as an interim step in producing report-sized maps (Figure 8), and for summarizing mapped data. Another feature is the selection of various combinations of printer characters in making the map symbol. By selecting appropriate print characters, maps which highlight certain features and visually distinguish the different map categories can be produced (Figure 8). Finally the mapping program allows discrete areas of the map to be shown against a background that outlines the entire study area. Intensive agriculture is depicted (Figure 8) by the heavy grey tone area, extensive agriculture by a lighter grey tone and the remainder of the country's land area with dots.

D. Mapped Information

Maps Geocoded

Seven maps were processed for the Land Information Subsystem prepared for SASA (Table 2). All maps were obtained from either Syrian sources or were developed by the CRIES project staff. The maps were obtained at various scales (Table 2, column 2) but were processed at either a scale of 1:200,000 or a scale of 1:750,000 (Table 2, column 3) depending upon each map's spatial complexity and type of information.

Figure 8.--Sample printer map depicting intensive and extensive areas of agricultural production in Syria.

Table 2.--Map Data Currently in the Syrian Land Information Subsystem.

Map Name	Original Scale	Processing Scale	Date	Base	Source
Administrative Boundaries (Mohafaza & Montika)	1:200,000	1:200,000	1973[1]	paper	Syria Topographic Map Series & the Ministry of Real Estate
Resource Planning Units	1:750,000	1:750,000	1979	mylar	Developed by CRIES project staff
Land Cover/Use	1:200,000	1:200,000	1979	mylar	Developed by CRIES project staff
Stabilization Zones	1:1,000,000	1:750,000	(unknown)	paper	Statistical Abstract, Central Bureau of Statistics
Soils	1:750,000	1:750,000	1979	mylar	Developed by CRIES project staff
Crop Climate	1:200,000	1:750,000	1979	mylar	Developed by CRIES project staff
Hydrologic Units	1:1,000,000	1:750,000	1974	paper	Syrian Ministry of Public Works & Hydrologic Resources

[1] Updated by CRIES project staff through secondary sources.

For purposes of geocoding, the processing scale determined which coding technique was used. As described earlier in this report, the 1:750,000 scale series was coded using a movable scale, with a unit distance of 2 km. The coding process was done using experienced technicians and rigorous verification. Despite this type of control, differences in map projections, the nature of the mapped information, and human error causes spatial error in the resulting data file. These types of problems will be more evident in the maps of complex mapping units, such as soils and RPUs. These problems will be minimized in maps of single mapping unit shapes, such as crop climate, hydrologic units, and stabilization zones.

For coding additional maps for the information system, particularly outside a controlled and experienced environment, the CRIES staff recommends that maps with complex mapping unit shapes be geocoded from a base map of 1:500,000 scale using a movable scale with a unit distance of 2 km. This scale would allow for easier location of the mapping unit boundaries.

Display maps were prepared for five maps (Table 3). This map series occurs on four sheets which correspond to the 1:500,000 scale base map of Syria. The map showing the administrative boundaries (at the Mohafaza and Mantika level) was compiled by tracing the boundaries as produced with the mapping phase of the mapping program. The remaining maps in this series were compiled through optical reduction or enlargement from the original map scale.

Tabulations

Tables 4 and 5 show the extent of Resource Planning Units by stabilization zone and hydrologic units as estimated from geocoded mapped information.

Table 3.--Display Maps at 1:500,000 Scale and Process Used for Compilation.

Map Name	Compilation Process
Administrative Boundaries	Traced from computer-produced map from Geographic Information System
Resource Planning Units	Optically enlarged from 1:750,000 scale
Soils	Optically enlarged from 1:750,000 scale
Crop Climate	Optically reduced from 1:200,000 scale
Stabilization Zones	Optically enlarged from 1:1,000,000 scale

Table 4.--Extent of Resource Planning Units (RPUs) by Stabilization Zone Estimated from Geocoded Mapped Information.

RPU Number	STABILIZATION ZONES (km^2) IA	IB	II	III	IV	V	RPU Total
1	0	0	0	32	618	9,001	9,651
2	76	0	964	412	376	4	1,832
3	79	0	1,829	1,282	90	0	3,280
4	212	0	528	352	473	0	1,565
5	1,746	0	76	12	0	0	1,834
6	554	0	16	0	0	0	570
7	0	0	0	0	0	24,078	24,078
8	0	0	0	204	448	288	940
9	36	0	96	466	581	456	1,635
10	0	0	0	0	4	680	684
13	0	0	0	0	36	2,858	2,894
15	488	0	374	68	381	190	1,501
16	71	0	0	0	0	0	71
17	0	0	0	0	0	1,944	1,944
18	0	0	0	0	0	5,684	5,684
19	0	0	0	444	1,100	11,628	13,172
20	296	0	4,774	2,656	280	324	8,330
21	0	0	0	0	52	1,152	1,204
22	0	0	0	0	44	399	443
23	28	0	176	64	116	0	384
24	311	0	332	98	72	96	909
25	1,944	56	20	0	0	0	2,020
26	3,038	0	797	0	0	0	3,835
27	254	0	0	0	0	0	254
28	926	0	0	0	0	0	926
29	176	72	0	0	0	0	248
30	1,415	2,356	0	0	0	0	3,771
31	0	0	0	828	648	40,080	41,556
32	0	0	0	0	0	3,430	3,430
33	0	0	0	0	0	604	604
34	792	68	0	0	0	0	860
35	201	224	0	0	0	0	425
36	2,075	0	0	0	0	0	2,075
37	544	0	0	0	0	0	544
38	392	36	1,940	216	0	0	2,584
39	0	0		0	0	2,468	2,468
40	0	0	342	523	366	1,680	2,911
41	0	0	236	640	248	20	1,144
42	0	0	0	0	0	912	912
45	0	0	0	0	84	1,311	1,395
46	0	0	1,028	1,126	3,076	4,980	10,210
47	487	0	0	0	0	0	487
48	0	0	772	1,028	848	1,324	3,982
49	0	0	417	418	36	0	871
50	0	0	1,003	896	36	0	1,935
51	0	0	152	272	898	916	2,238
52	2,563	0	1,598	464	0	0	4,625
53	140	0	1,109	158	0	0	1,407
54	1,433	0	128	0	0	0	1,561
55	311	0	0	0	0	0	311
56	404	0	0	0	0	0	404
57	0	0	2,592	1,544	20	0	4,156
58	499	0	0	0	0	0	499
Stabilization Zone Totals	21,441	2,812	21,299	14,203	10,931	116,507	187,193

Table 5.--Extent of Resource Planning Units (RPUs) by Hydrologic Units Estimated from Geocoded Mapped Information.

RPU	HYDROLOGIC UNIT (km^2) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	RPU Total
1	0	0	0	0	0	0	5,435	0	0	300	1,120	0	2,796	0	0	9,651
2	0	0	0	0	0	0	0	0	0	0	0	1,544	288	0	0	1,832
3	0	0	0	0	0	0	0	0	0	0	0	3,156	124	0	0	3,280
4	0	0	0	0	0	0	503	0	0	0	0	810	252	0	0	1,565
5	0	0	0	0	0	0	0	0	0	0	0	1,730	104	0	0	1,834
6	0	0	0	0	0	0	0	0	0	0	0	570	0	0	0	570
7	3,328	0	0	1,154	2,772	0	64	2,060	0	11,100	3,600	0	0	0	0	24,078
8	0	0	0	0	0	0	0	0	0	0	0	268	672	0	0	940
9	0	0	0	0	0	0	0	0	0	0	0	0	1,148	487	0	1,635
10	0	0	0	0	0	0	0	0	0	0	0	0	684	0	0	684
13	0	0	0	754	0	0	0	0	0	0	200	0	1,720	220	0	2,894
15	0	0	0	0	0	0	0	0	0	0	0	58	940	503	0	1,501
16	0	0	0	0	0	0	0	0	0	0	0	0	48	23	0	71
17	0	0	0	0	0	0	0	0	0	12	1,568	0	364	0	0	1,944
18	0	0	0	2,728	1,816	0	0	964	0	0	0	0	0	176	0	5,684
19	1,596	0	28	2,676	336	2,452	0	1,624	3,764	0	0	0	0	696	0	13,172
20	286	2,215	1,481	92	0	1,464	0	0	0	0	0	0	0	2,892	0	8,330
21	0	0	0	112	0	0	0	0	0	0	0	0	0	1,092	0	1,204
22	0	0	0	0	0	0	0	0	0	0	0	0	0	443	0	443
23	0	0	0	0	0	0	0	0	0	0	0	0	0	384	0	384
24	0	0	0	0	0	0	0	0	0	0	0	0	0	909	0	909
25	0	212	0	0	0	0	0	0	0	0	0	0	0	1,602	206	2,020
26	0	2,223	0	0	0	0	0	0	0	0	0	0	0	1,612	0	3,835
27	0	0	0	0	0	0	0	0	0	0	0	0	0	191	63	254
28	0	0	0	0	0	0	0	0	0	0	0	0	0	10	916	926
29	0	0	0	0	0	0	0	0	0	0	0	0	0	244	4	248
30	0	0	0	0	0	0	0	0	0	0	0	0	0	536	3,235	3,771
31	19,460	36	1,896	0	452	1,764	0	13,172	4,776	0	0	0	0	0	0	41,556
32	3,430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3,430
33	604	0	0	0	0	0	0	0	0	0	0	0	0	0	0	604
34	0	0	0	0	0	0	0	0	0	0	0	0	0	860	0	860
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	425	425
36	0	228	0	0	0	0	0	0	0	0	0	0	0	1,788	59	2,075
37	0	108	0	0	0	0	0	0	0	0	0	0	0	436	0	544
38	744	496	0	0	0	160	0	0	0	0	0	0	0	1,184	0	2,584
39	872	0	0	0	0	0	0	0	1,596	0	0	0	0	0	0	2,468
40	2,507	0	404	0	0	0	0	0	0	0	0	0	0	0	0	2,911
41	124	508	204	0	0	308	0	0	0	0	0	0	0	0	0	1,144
42	912	0	0	0	0	0	0	0	0	0	0	0	0	0	0	912
45	1,395	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,395
46	10,210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,210
47	0	0	0	0	0	0	0	0	0	0	0	0	0	487	0	487
48	2,568	0	1,404	0	0	0	0	0	0	0	0	0	0	0	0	3,972
49	871	0	0	0	0	0	0	0	0	0	0	0	0	0	0	871
50	1,935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,935
51	2,238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,238
52	4,625	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,625
53	1,407	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,407
54	1,561	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,561
55	311	0	0	0	0	0	0	0	0	0	0	0	0	0	0	311
56	404	0	0	0	0	0	0	0	0	0	0	0	0	0	0	404
57	3,912	0	244	0	0	0	0	0	0	0	0	0	0	0	0	4,156
58	0	352	0	0	0	0	0	0	0	0	0	0	0	97	0	499
Total	65,300	6,278	5,661	7,516	5,376	6,148	6,002	17,820	10,136	11,412	6,488	8,136	9,140	16,872	4,908	187,193

Comparisons of Geocoded and Statistical Information

Preliminary comparisons were made between mapped (geocoded) and reported (statistical) information for subject maps on stabilization zones, general land use categories, and the administrative boundaries.

Tentative explanations of the differences in geocoded and statistical information are put forth for each map. Most crucial, in terms of resolution of differences, is the rectification of differences between geocoded and statistical information on the extent of the administrative units-mohafazat and mantika - within the Syrian Arab Republic. The mapped land use data used for comparison in this section with statistical data are based on a preliminary interpretation. Concurrent with the writing of this report, field activities are underway in Syria to verify and finalize the general land use mapping units. The lack of correspondence between the mapped and statistical information on stabilization zones is thought to be attributable to the use of a too-generalized stabilization zone map for geocoding.

Administrative Boundary Comparisons

A consistent set of map sheets, cartographically produced in 1968, showing topographic and administrative boundary detail at a scale of 1:200,000 covering the Syrian Arab Republic was obtained through efforts of SASA personnel. These map sheets were provided by SARG for processing by the CRIES project staff.

The national, regional (mohafaza), and subregional mantika administrative boundaries were geocoded and digitized from these maps, and compared with land area by these administrative units (mohafaza and mantika) reported in the 1968 Statistical Abstract for the Syrian Arab Republic. The absolute and percentage differences between the mapped (geocoded) and reported (statistical) area totals were beyond the error margins acceptable for preliminary inventory and assessment purposes (Table 6) Many of these differences were thought to be due to regionalization changes subsequent to 1968.

In March 1979, SARG provided a set of map sheets to the CRIES project staff, most at a scale of 1:100,000, covering the Syrian Arab Republic (except Quneitra). These map sheets were provided by the Department of Real Estate, MAAR and were deemed "most current." The map sheets were the product of a continuing cadastral survey and show administrative boundaries by village.

Using the 1:100,000 scale map sheets, the administrative boundaries on the 1968, 1:200,000 scale map sheets were updated. The revised 1:200,000 map sheets were geocoded and the extent of the administrative boundaries were recomputed. These recomputed areas for the administrative boundaries were compared with statistical areas for the administrative units (mohafaza and mantika) reported in 1977 by the Department of Real Estate (Table 6). Absolute and percentage differences in the mapeed (geocoded) and reported (statistical) areas were calculated from the revised maps.

Table 6.—Mapped and Statistical Subregional Administrative Unit Land Area Totals and Comparisons for the Syrian Arab Republic, 1968 and 1977.

		1968				1977			
Mohafaza	Montika	Geocoded	Statistical	Absolute Difference	Percent Difference	Geocoded	Statistical	Absolute Difference	Percent Difference
		- - - - - - - - -(km^2)- - - - - - - -			%	- - - - - - - - -(km^2)- - - - - - - -			%
Damascus	Damascus[1/]	984	1,134	- 150	- 13	989	1,132	- 143	- 13
	Duma and El Tal	12,141	12,000	+ 141	+ 1	12,129	12,002	+ 127	+ 1
	Qatana	984	944	+ 40	+ 4	987	793	+ 194	+ 24
	Zabadani	636	650	- 14	- 2	636	650	- 14	- 2
	Nabek[2/] and Qatifa	2,385	3,560	- 1,175	- 33	3,270	3,560	- 290	- 8
Dar'a	Dar'a	1,613	1,650	- 37	- 2	1,613	1,650	- 37	- 2
	Izra	2,247	2,080	+ 167	+ 8	2,247	2,080	+ 167	+ 8
Sweida	Sweida	2,552	1,470	+ 785	+ 53	2,552	1,470	+ 785	+ 53
	Shahba	2,070	2,010	+ 60	+ 3	2,070	2,010	+ 60	+ 3
	Salkhad	2,032	2,070	- 38	- 2	2,032	2,070	- 38	- 2
Qunitra	Qunitra	1,258	1,300	- 42	- 3	1,258	1,451	- 193	+ 13
	Zoia	413	410	+ 3	+ 1	413	410	+ 3	+ 1
Homs	Homs	6,635	8,555	- 1,920	- 22	8,781	8,401	+ 350	+ 4
	Talkalakh	593	540	- 53	- 10	589	738	- 149	- 20
	Mokhram	3,130	2,965	+ 165	+ 6	3,349	2,965	+ 384	+ 12
	Rastan	301	333	- 32	- 10	301	333	- 32	- 10
	Tadmar	38,815	29,105	+ 9,710	+ 33	36,764	29,105	+ 7,659	+ 26
	Qasir	795	727	+ 68	+ 9	800	681	+ 119	+ 17
Hama	Hama[3/]	2,853	2,689	+ 165	+ 6	2,990	2,668	+ 322	+ 12
	Salamiya	5,801	4,513	+ 1,288	+ 29	5,652	4,513	+ 1,139	+ 25
	Masiaf	803	638	+ 165	+ 26	775	638	+ 137	+ 21
Ghab	Ghab	976	1,004	- 28	- 3	960	1,042	- 82	- 8
Tartous	Tartous[4/]	609	560	+ 49	+ 9	704	772	- 68	- 9
	Banias	669	720	- 51	- 7	622	585	+ 37	+ 6
	Safita[5/]	666	610	+ 56	+ 9	636	535	+ 101	+ 19
Lattakia	Lattakia	1,007	1,000	+ 7	+ 1	1,063	1,000	+ 63	+ 6
	Hafa	691	657	+ 34	+ 5	494	317	+ 177	+ 56
	Jableh[6/]	737	780	- 43	- 6	881	979	- 98	- 10
Idleb	Idleb	1,255	1,114	+ 141	+ 13	1,254	1,177	+ 77	+ 7
	Harem	807	820	- 13	- 2	808	820	- 12	- 1
	Jisr	649	1,045	- 396	- 38	663	1,045	- 382	- 37
	Ma'ra	2,196	2,360	- 164	- 7	2,070	2,342	- 272	- 12
	Ariha	611	595	+ 16	+ 3	611	735	- 124	- 17
Alleppu	Azaz	1,237	1,648	- 411	- 25	1,237	1,648	- 411	- 25
	A'farin	1,979	2,050	- 71	- 3	1,979	2,050	- 71	- 3
	Bab	1,946	1,660	+ 286	+ 17	1,602	1,660	- 58	- 3
	Manbaj	4,780	2,764	+ 2,016	+ 73	5,437	4,164	+ 1,273	+ 31
	Jarablos	950	1,105	- 155	- 14	951	1,105	- 154	- 14
	A'in el A'rb	2,836	2,730	+ 106	+ 4	2,836	2,730	+ 106	+ 4
	Jabl Sam'an	5,443	4,185	+ 1,258	+ 30	5,787	4,121	+ 1,666	+ 40
Hasakeh	Hasakeh	12,155	12,154	+ 1	----	12,155	12,212	- 57	----
	Qamishli	3,904	4,006	- 102	- 3	3,904	4,022	- 118	- 3
	Mal Kai	2,702	3,372	- 670	- 20	2,702	3,356	- 654	- 19
	Ras El A'in	3,869	3,839	+ 30	+ 1	3,981	3,743	+ 238	+ 6
Raqa	Raqa	13,062	12,001	+ 1,061	+ 9	12,747	10,601	+ 2,146	+ 20
	Tel Abiad	4,825	9,999	- 5,174	- 52	4,966	10,036	- 5,070	- 51
Dier El Zor	Dier El Zor	15,252	13,600	+ 1,652	+ 12	14,657	13,600	+ 1,057	+ 8
	Maiadin	8,183	15,950	- 7,767	- 49	8,183	15,950	- 7,767	- 49
	Bokamal	3,136	3,510	- 374	- 11	3,136	3,510	- 374	- 11
Syrian Arab Republic		187,174	185,181	+ 1,993	+ 1	187,193	185,180	+ 2,013	+ 1

1/ Damascus Montika includes Damascus City Montika and Doria Montika, both established in 1976.

2/ Nabek Montika includes Yabarod Montika, established in 1976.

3/ Hama Montika includes Mahrda Montika, established in 1974.

4/ Tartous Montika includes Shekh Badr Montika, established in 1973.

5/ Safita Montika includes Darikish Montika, established in 1970.

6/ Jableh Montika includes Qardaha Montika, established in 1972.

7/ Jabl Sam'an Montika includes Safira Montika, established in 1976.

Note: Absolute Difference = Mapped - Statistical

$$\text{Percent Difference} = \frac{\text{Mapped - Statistical}}{\text{Statistical}} \times 100.$$

The regional (mohafaza) or (mohafaza) or subregional (mantika) mapped and statistical areas are not sufficiently consistent for either 1968 or 1977 to warrant the reporting of other mapped information (i.e., RPU map, hydrologic unit map, etc.) by internal administrative units within the Syrian Land Information Subsystem. However, the national totals for mapped and statistical information are sufficiently close to allow reporting of the resource use maps by extent for they Syrian Arab Republic as a whole.

It is suggested that SASA personnel review with SARG mapping specialists and specialists responsible for the reporting of statistical information the lack of correspondence in extent (area) of the internal administrative units. Accurate correspondence is crucial in the establishment and use of the mapped land information subsystem. Although analysis is performed by resource units, resource policy will generally be implemented within the context of existing administrative units. Cross-referencing administrative units by resource units or classifications using the mapped information subsystem is a key step to providing policy makers with appropriate information summaries.

Stabilization Zone Comparisons

Comparison of the geocoded information tabulated for the stabilization zones with information reported in the Statistical Abstracts indicated two major discrepancies. There was a 43 percent underestimation of the area in Zone IV, a difference of 8,139 km^2. For Zone V there was an overestimation of 15,247 km^2 -- approximately a 15 percent overestimation.

To isolate the source of the major difference, and the less consequential differences in other zones, the original 1:1,000,000 map obtained through SASA efforts and a 1:1,000,000 computer line printer map prepared from the geocoded information were compared. There is a high degree of correspondence in the two maps. This means the differences are not attributable to geocoding process.

There are two possible reasons for the difference. One is that the 1:1,000,000 map is too generalized or outdated. The second is that the statistical information is reported erroneously. Both of these possibilities should be reviewed by SASA personnel.

E. Maps and Map File Codes

Figure E1. Generalized map of Syrian Administrative Boundaries

Table E2. Map and Map File Codes for the Administrative Boundary Map

Table E3. Map and Map File Codes for the Land Cover/Use Map

Figure E4. Generalized map of Syrian stabilization zones

Table E5. Map and Map File Codes for the Stabilization Map

Figure E6. Generalized map of Syrian hydrologic units.

Table E7. Map and Map File Codes for the Hydrologic Unit Map.

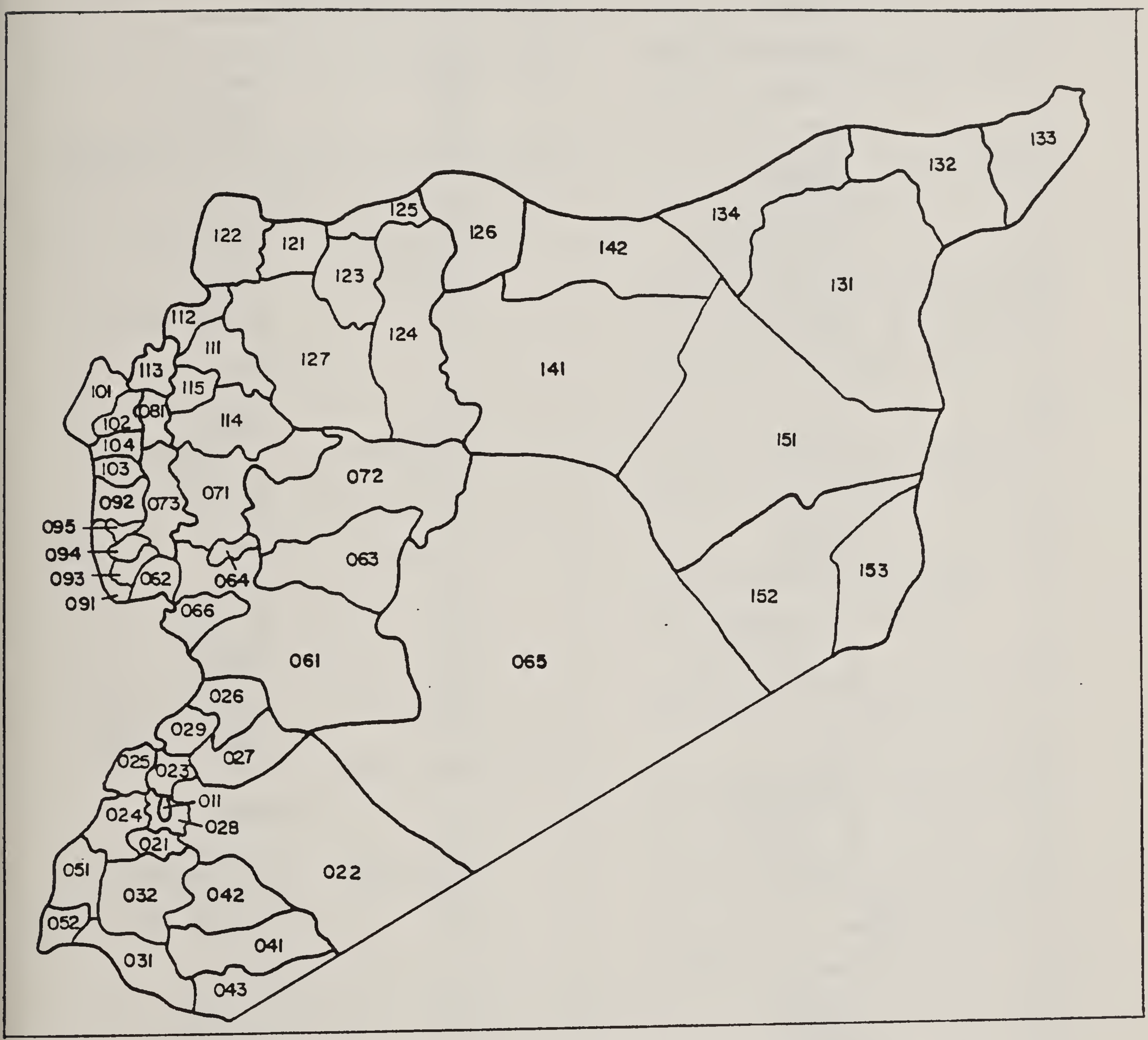


Figure E1.--Generalized map of Syrian Administrative Boundaries.

Table E2.--Map and Map File Codes for the Administrative Boundary Map.

Numeric Code	Mohafaza/Montika	Numeric Code	Mohafaza/Montika
01	Damascus City	09	Tartous
011	Damascus City	091	Tartous
02	Damascus	092	Banies
		093	Sofita
021	Damascus	094	Darikish
022	Doma	095	El Shikh Bdar
023	El Tal	10	Lattakia
024	Qatna		
025	El Zbadani	101	Lattakia
026	El Nabok	102	El Hafa
027	El Qatifa	103	Jabla
028	Doria	104	El Qardaha
029	Yabarod	11	Idleb
03	Dara	111	Idleb
031	Dara	112	Haram
032	Azra	113	El Jasar
04	Sweida	114	El Ma'ra
		115	Ariha
041	Sweida	12	Allepo
042	Shhaba		
043	Salkhad	121	A'zaz
05	El Qunitra	122	A'farin
		123	El Bab
051	El Qunitra	124	Manbaj
052	El Zoia	125	Jarabls
06	Homs	126	A'in El A'rb
		127	Jabl Sam'am
061	Homs	128	Safira
062	Talakakh	13	Hasakeh
063	El Makhrm		
064	El Rastan	131	Hasakeh
065	Tadmar	132	El Zamashli
066	El Qasir	133	El Malkai
07	Hama	134	Ras El A'in
071	Hama	14	El Raqa
072	Salmia	141	El Raqa
073	Masief	142	Tal Abiz
074	Mahrda	15	Dier El Zor
08	Ghab	151	Dier El Zor
081	Ghab	152	El Maiadin
		153	El Bokmal

Table E3.--Map and Map File Codes for the Land Cover/Use Map.

Code	Land Cover/Use Type	Description
1	Intensive Agriculture	Areas with multiple cropping, usually under irrigation
2	Extensive Agriculture	Areas normally cultivated with single crop, usually dry land farming
3	Range	Areas where the potential natural vegetation is predominantly grass-like plants, forbes or shrubs that can be used for grazing
4	Water	Areas covered by water year round, i.e., lakes, ocean, reservoirs
5	Urban	Areas in intensive use with much of the land covered by man-made structures
6	Forest	Areas of mixed deciduous and evergreen trees
7	Orchards	Areas of cultivated fruit, olive and nut trees, primarily non-irrigated
8	Barren	Areas of land with limited ability to support vegetation (less than one-third vegetation cover), primarily salt beds

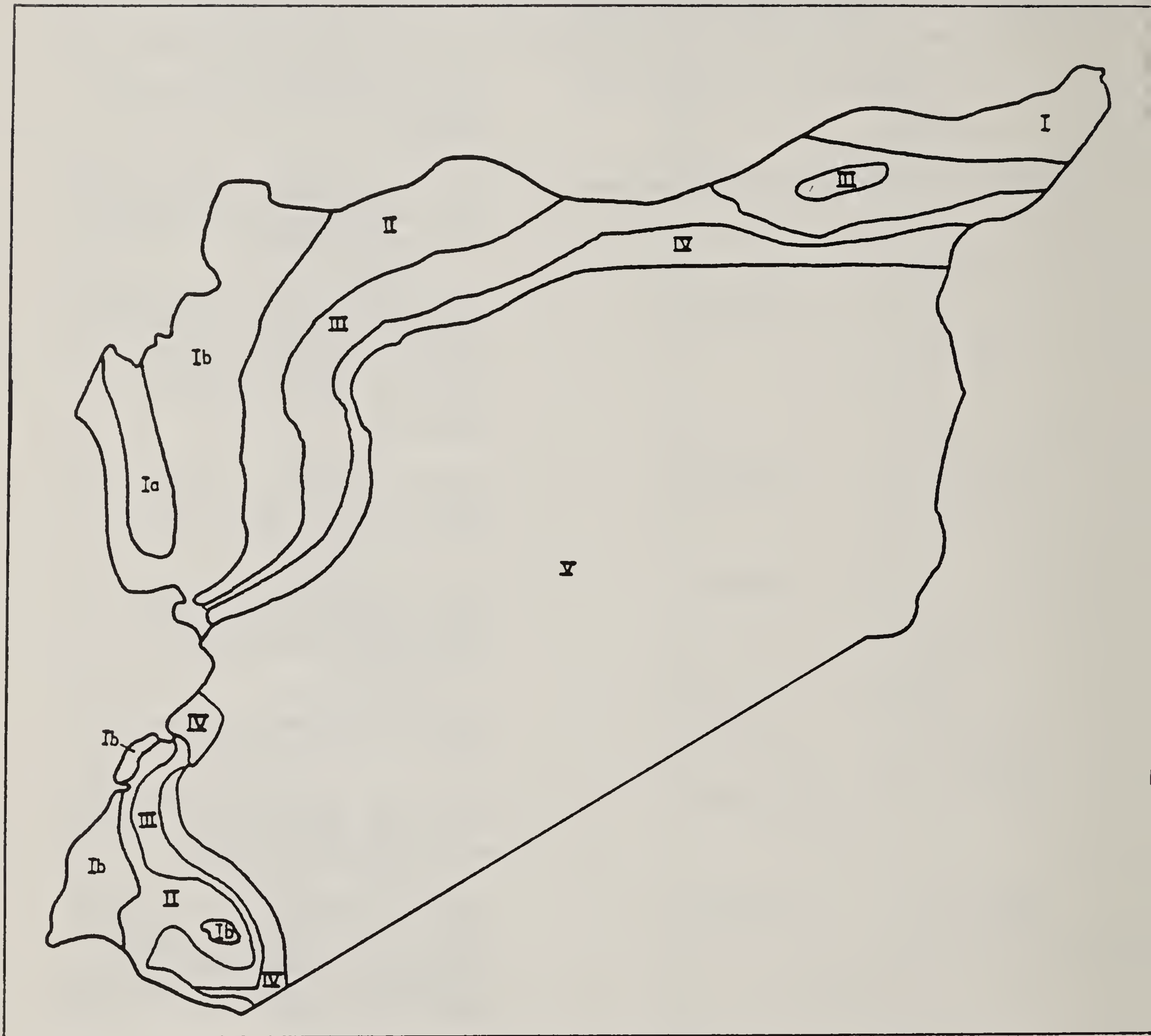


Figure E4.--Generalized map of Syrian stabilization zones.

Table E5 .--Map and Map File Codes for the Stabilization Map.

Map File	Map Code[1]
1	IA
2	IB
3	II
4	III
5	IV
6	V

[1]For descriptions of Stabilization Zones, refer to Statistical Abstract, 1978, Syrian Arab Republic, Central Bureau of Statistics.

Figure E6.--Generalized map of Syrian hydrologic units.

Table E7.--Map and Map File Codes for the Hydrologic Unit Map.

Code	Basin Name
1	Jesireh
2	Kwaik
3	Jabboul
4	Al-Daw
5	Palmyra
6	Kanasser
7	Al-Zalf
8	Wa Dil-Miyah
9	Al-Rasafa
10	Al-Tanf
11	Al-Sabi-Byar
12	Horan
13	Damascus
14	Oronte
15	The Coast (Mediterranean)

Appendix 3

Land Cover/Use Map From Landsat Imagery

A. Introduction

In order to analyze the land cover/use patterns of the agricultural resource base in Syria, it was necessary to process Landsat imagery into an interpretable format, and then produce a land cover/use map. This appendix outlines the steps taken in acquiring Landsat imagery, and details the procedure involved in the interpretation and mapping process.

Imagery Acquisition

Landsat imagery has much to offer Syria in its resource inventory assessment because of the unavailability of complete aerial photographic coverage of the country.

Landsat data are available in a wide variety of interpretable formats: computer-compatible tapes, film positives and negatives, paper prints and transparencies. Photographic products are available in several format sizes ranging from 55.8mm to 74.2cm. The first sets of Landsat imagery for Syria were ordered in early September 1978 from the Earth Resources Observation Systems (EROS) Data Center, Sioux Falls, South Dakota, USA. Portions of 17 Landsat images were needed for complete coverage of Syria (Fig. 1). The following imagery was ordered:

1. 80 Landsat black-and-white positive transparencies--55.8mm
2. 80 Landsat black-and-white positive transparencies--18.5cm
3. 14 Landsat false color composite transparencies--18.5cm.

Image quality ranged from good to excellent in all instances. A list of EROS imagery ordered for Syria is shown in Table 1 at the end of this appendix.

It was impossible to obtain Landsat coverage of Syria more current than 1976 from EROS because the EROS Data Center no longer competes with foreign centers in the production of Landsat products over areas outside of its own domain. According to the Committee on Remote Sensing for Development (1977), 18 receiving stations have been planned to create a worlwide network. Some of these are already in operation, Table 2. The receiving station at Fucino, Italy is the only center presently receiving and processing Landsat data of Syria and this information is available from the user facility at Telespazio, Rome, Italy. In the future, an operating receiving station in Iran would also receive Landsat data of Syria.

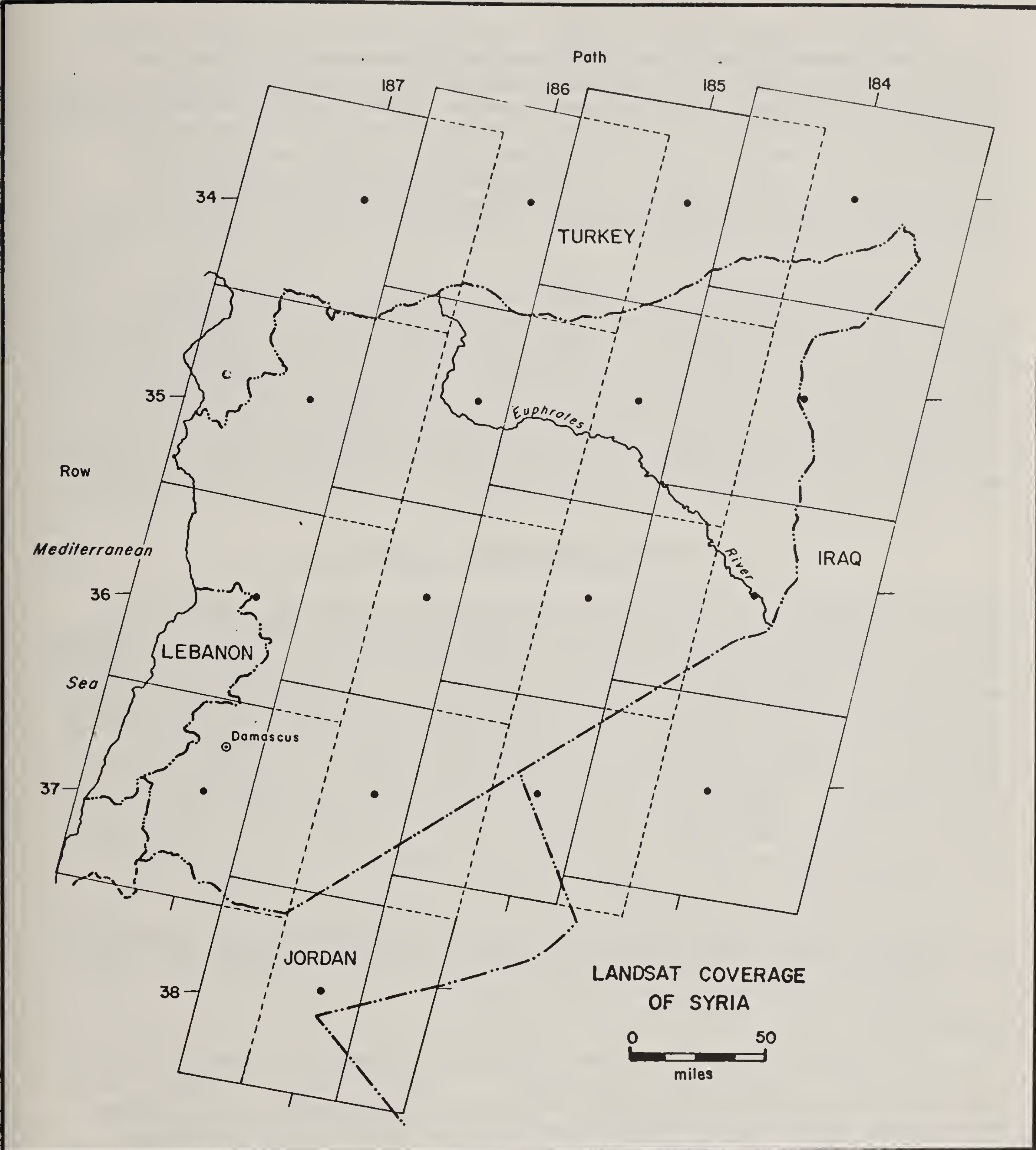


Figure 1.--Landsat Coverage and Nominal Centers for Syria.

Prior to the November 1978 trip to Syria by the Land Cover/Use Inventory Team of the CRIES project, a request was made to Telespazio for a list of imagery available for Syria. Because no information was received prior to the November field activities in Syria, a member of the Land Cover/Use Inventory Team visited Telespazio in early December to obtain a listing of the available imagery for 1977 and 1978. In early January 1979, an order was placed for complete sets of Landsat imagery for February, May, and September of 1978 (51 total sets). These time frames were chosen in an attempt to maximize interpretability of land cover/use features. A list of Telespazio imagery ordered for Syria is given in Table 3.

Because of the time delays experienced in obtaining information from Telespazio, arrangements were made through the Agricultural Attache in the United States Embassy in Rome to send the imagery to the CRIES project offices in East Lansing, Michigan, USA. Although this arrangement speeded delivery, the initial 31 sets of imagery from Telespazio did not arrive in Michigan until March 26, 1979. The remaining 20 sets were delivered in mid-April and early May 1979. The usefulness of the relatively costly Telespazio imagery (as compared to similar products previously available from the EROS Data Center) was further limited because of scaling problems and the extremely poor quality of the images.

B. Interpretation and Mapping Procedures

The preparation of the Land Cover/Use map for Syrian was completed in three major stages. A preliminary evaluation of the Landsat imagery was undertaken to establish test areas that were representative of land cover/use patterns in Syria. The test areas selected were interpreted using standard techniques and these interpretations were used for verification purposes during the initial ground truth work. The second stage in the procedure involved the comprehensive mapping of land cover/use for Syria from Landsat imagery with supplemental field data. During this process, invaluable assistance was received from two Syrian technicians who were in East Lansing for a Landsat Interpretation Training Course. Completion of the project involved a final field check of persistent problem areas that occurred during the interpretation, a re-interpretation of these areas in the light of field information, and preparation of final map products.

The following descriptions of the interpretation and mapping procedures are organized around these three major stages, and follow a chronological order from September 1978 to September 1979.

First Stage

The initial task was to gather collateral information to familiarize the interpreters with ground conditions in Syria. This information included government reports, maps, and agricultural statistics. Concurrently, the literature dealing with the use of Landsat data for resource inventories in developing

nations was reviewed to assist in the development of pre-field work interpretation procedures. Special attention was given to articles by Tawfik et al. (1972), Richardson et a. (1977), and the Committee on Remote Sensing (1977). See list of references at end of appendix.

Test Areas and Preliminary Field Work

The first step in the interpretation procedure was to review the available Landsat images of Syria and select a set of test areas that were representative of land cover/use patterns found in the country. Eight test areas were selected (Fig. 2) and preliminary land cover/use interpretations were made for them on a back-lighted projector at a scale of 1:250,000. Interpretations were confined to a general Level I classification and included Agriculture, Urban, Water, Range, Barren and Forest. Tracing paper copies were made of these interpretations and were taken into the field so that the interpreters could associate the interpreted patterns with actual land cover/use patterns in Syria. Associating these patterns with the range of tone and texture patterns that exist on Landsat imagery was also integrated into field checking at this time. Another important function of ground truthing at this stage was the information it contributed to a decision on the nature of the final classification system.

The first field trip to Syria was conducted in November/December 1978 and all test areas, except number 6, were checked.

Initially, 24 days of intensive field work were planned for areas outside of Damascus. However, it was not possible to carry out this field work as scheduled. Logistical problems with vehicle and Syrian counterpart staff availability reduced the 24 days of planned field work to 10 days. The 10 days of field work were divided into three parts. The first three days consisted of one-day field trips in the Damascus area. The second part involved a four-day trip across the desert to Al-bu Kamal, then northwest to Al-Hasakeh and back along the Euphrates River to Aleppo, and then back to Damascus. The last three-day trip consisted of a quick reconnaissance from Damascus to Lattakia and the Ghab.

Although the Land Cover/Use Inventory Team was able to pass through seven of the eight test areas shown in Figure 2, the reduced time and rearranged itinerary resulted in a less thorough job than anticipated. The field work was further complicated by the overall delay in project initiation which put the Land Cover/Use Inventory Team into the field during a time when few crops were discernable in the cultivated areas. Although the 10 field days allowed a rapid traverse of the country, the nature of field work activities was changed from a detailed field check to a reconnaissance survey.

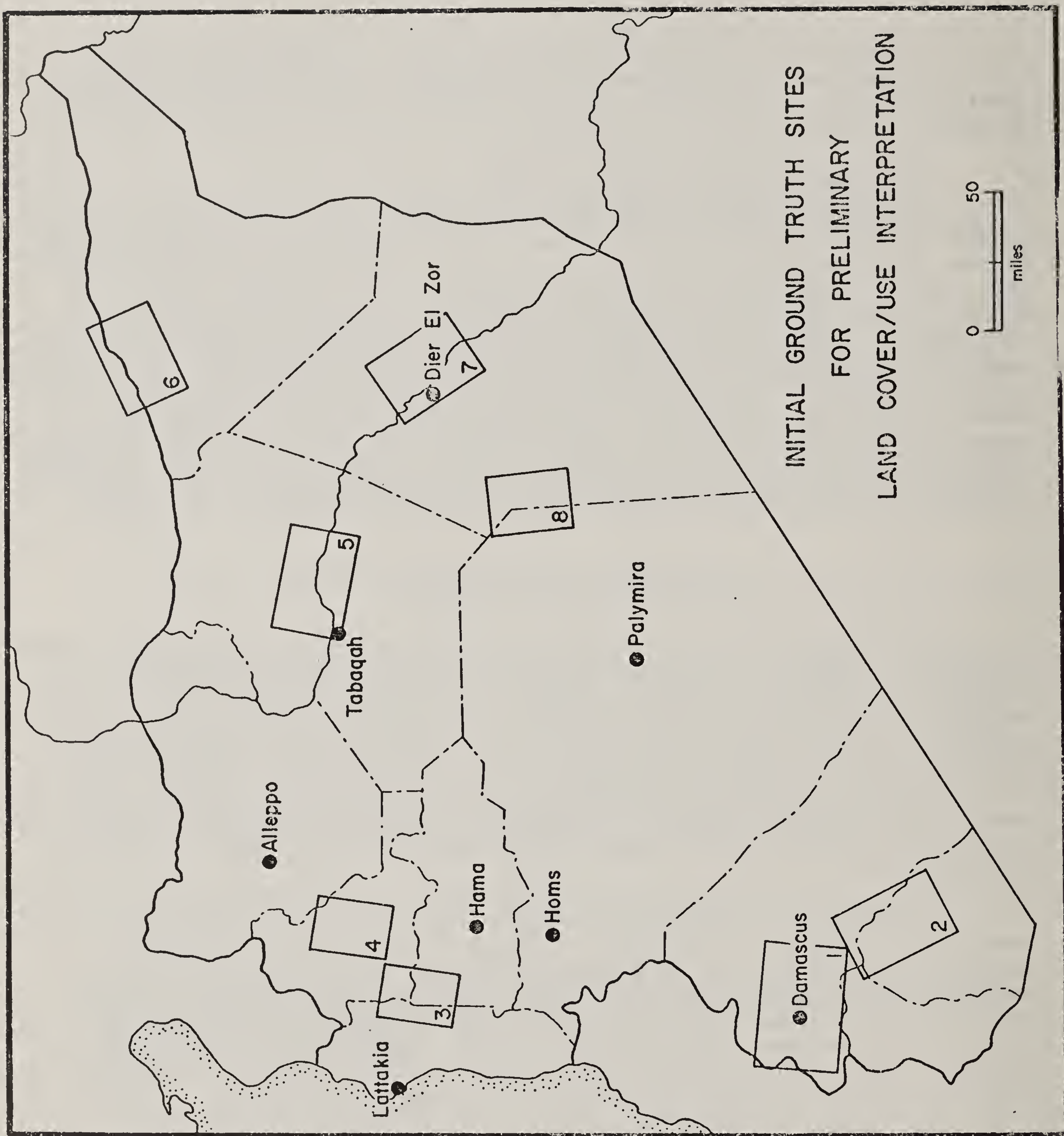


Figure 2.--Initial Ground Truth Sites for Preliminary Land Cover/Use Interpretation.

Classification Scheme

The purpose of a classification system is to provide the interpreter with a means to group different land cover/use types. The classification system is broken down into categories that become the legend of the map produced. Deciding on the final grouping is an involved process that considers the data source for the inventory, the nature of land cover/use patterns that have to be inventoried, and the use to which the final informaton will be put. In this instance, the final classification was designed to meet the needs of the resource economists of the CRIES project. These needs dictated a Level I land cover/use classification that would be closely compatible with the land use statistics collected by the Syrian government for administrative units in the country. By using compatible land cover/use classes, the data taken from the Land Cover/Use map were intended to be a partial basis for allocating published statistics to resource planning units and stabilization zones for further analysis.

Visual interpretation of Landsat imagery was structured to describe mutually exclusive categories applicable to Syrian land cover/use patterns. The categories and descriptions decided upon were as follows:

Generalized Land Cover/Use Classification
for Syria

1. Intensive Agriculture--indicates areas with multiple cropping, usually under irrigation
2. Extensive Agriculture--indicates areas normally with a single crop, usually nonirrigated farming
3. Range--indicates areas where the potential natural vegetation is predominantly grasslike plants, forbs, or shrubs that can be used for grazing
4. Water--indicates areas covered in water year-round--ocean, lakes, reservoirs, and rivers
5. Urban--indicates areas of intensive use with much of the land covered by manmade structures
6. Forest--indicates areas of mixed deciduous and evergreen trees
7. Orchards--indicates areas of cultivated fruit, olive, and nut trees, primarily nonirrigated
8. Barren--indicates areas of land with limited ability to support plant plant life and loss than onethird of the area covered in vegetation.

Second Stage

Comprehensive mapping of land cover/use for the total area of Syria was initiated in January 1979, using the Landsat imagery available from the EROS Data Center. Modifications and updating of these interpretations were made in March and April 1979 from Landsat imagery acquired from Telespazio. Prior to mapping, certain enhancement procedures were undertaken.

Image Enhancement

Image enhancement is the alteration of the original image to accentuate specific features. In this instance, three methods were used: 1) an optical color additive process; 2) a diazo process; and 3) an enlargement process.

The primary enhancement technique used was enlargement on a back-lighted projector. The back-lighted projector used has an optical projection system for magnifying transparent photographic images onto a 1 m^2 glass tracing surface, with magnification capabilities ranging from 2 to 32 times. By using the various projection lenses available, 18.5cm (1:1,000,000) and 55.8mm (1:3,369,000) images were projected up to a scale of 1:200,000. All final mapping was accomplished on this projector.

A color additive viewer was also used to enhance specific land cover/use features. This viewer was used to create false color composities from Landsat 55.8mm positive black-and-white images. The viewer enables the user to alter three additive colors (red, blue, and green), and light intensity for each of the three multispectral bands (4, 5, and 7) available from Landsat, thus adding or subracting tonal information found on each image. Once the proper tonal variation was achieved, a 70mm Hasselblad camera was attached to the viewer and a photograph (color transparency) was taken of the false color composite image. The color transparency was then placed in the projector and enlarged to 1:200,000 for mapping purposes.

The third form of enhancement used was diazo processing. Positive black-and-white 18.5cm transparencies for bands 4, 5, and 7 were used in this process. Each band of imagery was placed over a diazo film, emulsion to emulsion, and exposed tu ultraviolet light for varying lengths of time to enhance desired features. The diazo film was then run through a processing machine exposing each side of the film to an ammonia mixture. The ammonia works as a developing and setting agent for the diazo film. Because the back-lighted projector's light source gives off sufficient heat to cause warping of the diazo film, photographic transparencies were again made. The best results came from using 70mm format film. These images were put into the projector and scaled up to 1:200,000.

Mapping Procedure

False color composites obtained directly from the EROS Data Center were used as the basis for developing a preliminary land cover/use map of Syria. In three instances, false color composites did not exist and had to be generated from black-and-white positive transparencies using the methods outlined in the previous section.

Base maps were prepared on frosted mylar from the 1:200,000 topographic maps provided by the Syrians. The actual land cover/use interpretations were made directly onto these maps using the back-lighted projection system. Precise scale matching was accomplished by placing a grid over the false color transparencies and taking measurements from the screen.

Prior to actual mapping, the interpreter reviewed field notes, maps, and pertinent 35mm slides taken in November and December 1978 in the areas to be mapped. It was quite useful to project these slides during the interpretation process as they aided in the separation of tone, texture, and ground patterns into specific land cover/use categories. Land cover/use patterns, in the form of discrete areas of 0.5km^2 or larger (the minimum type size) were delineated from the projected image onto the frosted mylar base maps in the mapping process.

This mapping was completed using a good quality but varied image data base. The time frame of the images used ranged from 1972 to 1976 and so the resultant map product, while consistent within the limits of the interpretation procedures and classification system, had to be considered as a preliminary product.

Revision of the Preliminary Maps

The most consistent and timely imagery of Syria was acquired for 1978 and a multi-season image set was ordered. The order had to be placed with Telespazio and as previously indicated, the first package of Telespazio imagery was not received until March 1979. At this time an updating and revision of the completed preliminary land cover/use map was initiated. Mohyeddin M. Taha and Abdul-Rahim Loulou from the sector assessment counterpart staff were in East Lansing to participate in a Landsat Interpretation Training Course at this time, and the update and revision of the preliminary land cover/use map was made an integral part of their training.

Diazo false color composite were prepared from bands 4, 5, and 7 of the Telespazio imagery. The original images were of extremely poor photographic quality. These images had been reproduced on very high-contrast, grainy film causing many of the less apparent tonal contrasts to completely disappear. This characteristic meant that diazo enhancement added relatively little to the interpretability of these images. Some updating, for example, the major changes in cropping patterns found between Aleppo and the Al-Assad reservoir, was

accomplished through direct identification of tone levels from the band 7 image which was projected onto the preliminary land cover/use map. Scaling of the images was a problem which prevented an update interpretation of a complete image; however, registering small sections to the preliminary land cover/use map and then delineating the variations proved to be an adequate procedure.

In areas where the Telespazio image quality was too poor to warrant revisions, as in the coastal region, the land cover/use map was registered to the original false color composite. Collateral information for each problem area, with a particular emphasis on the ground shots from the November/December field trips, was then reviewed with Mr. Taha and Mr. Loulou so that revisions based on knowledge of the area could be made to the preliminary map. Changes of this kind were kept primarily to reclassifications of Forest to Orchard or Extensive Agriculture to Orchards. Areas where changes were suggested but that did not appear on the imagery became primary field check sites for the final field verification.

Third Stage

Field Verification

The final field verification was planned for late May/early June 1979 to coincide with presence of irrigated crops and the harvest of grain crops. The field work was actually accomplished during the last two weeks of July 1979 and this introduced certain of the seasonality problems experienced during the November/December 1978 field trip.

Field work was directed at areas that had posed persistent problems during the interpretation of areas where the EROS imagery was considerably out of date and the Telespazio imagery of very poor quality. Four cities were used as base locations--Damascus, Palmyra, Lattakia, and Aleppo (Fig. 3). The area surrouding Damascus was checked in a series of one-day trips to Al-Zabadani for orchard development, Dar'a and Al-Sweida to check the tonal variation between cropland and range, and several other areas to the north and east of Damascus for orchard development and the Extensive Agriculture/Range boundary. Confirmation of interpreted Extensive Agricultural development in the central Steppe was of primary importance in Palmyra. The coastal and north central portions of Syria were covered in a series of trips originating from Lattakia and Aleppo. North of Aleppo the Extensive Agriculture/Orchard interface was the critical problem to check. East from Aleppo the extent of land coming under irrigation with water from the Euphrates Dam was checked. In the Lattakia area, field work consisted of travelling a number of roads between the coast and the mountains checking the Extensive Agriculture/Orchard and Orchard/Range interfaces.

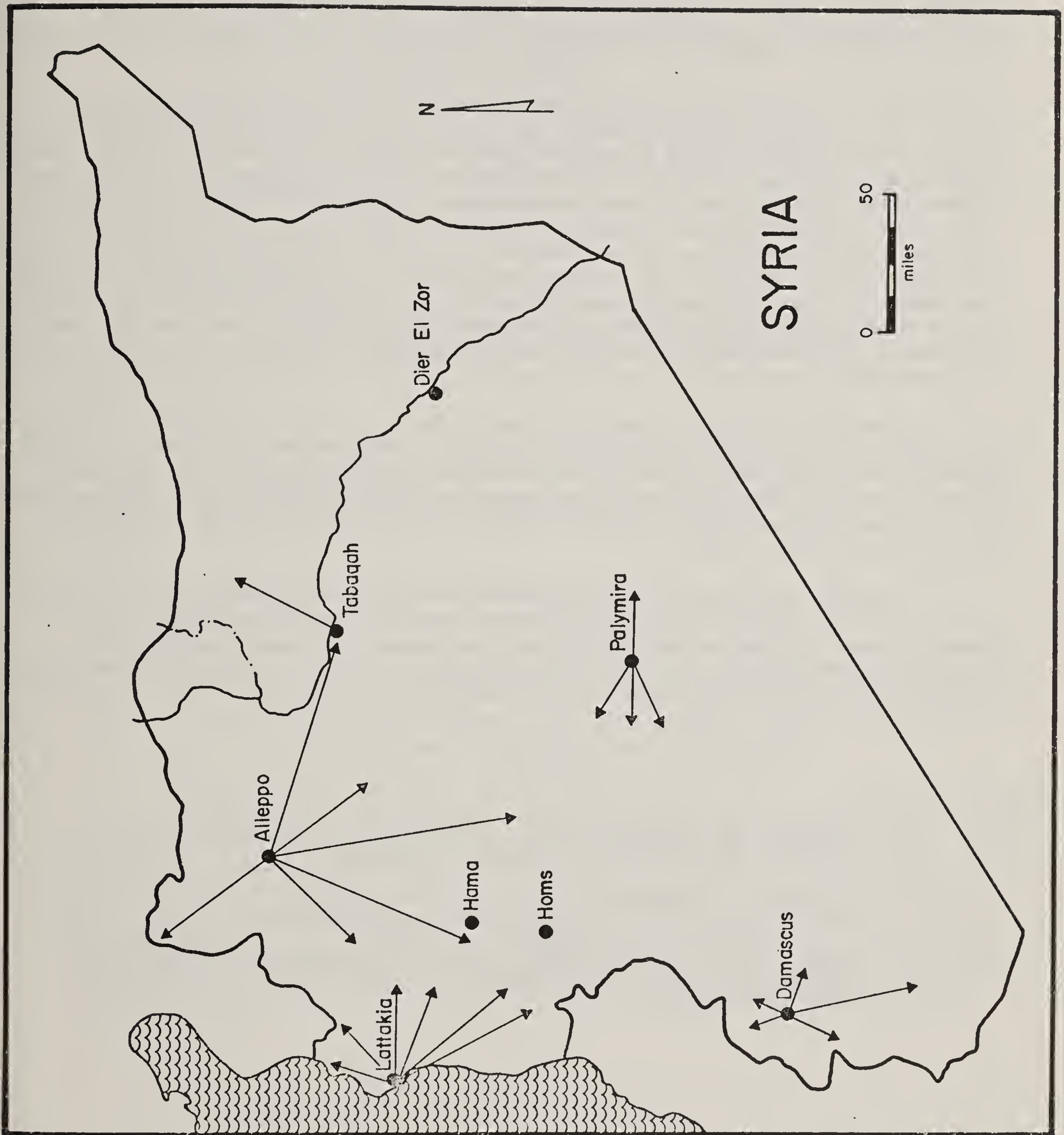


Figure 3.--Final Field Verification Routes.

The results of the field trip indicated that some of the working map delineations from the preliminary interpretation needed modification. North of Aleppo, both to the east and west, large areas classified as Extensive Agriculture were reclassified as Orchard (primarily olives, and olives interspersed with vines). Also, some land classified as Range was reclassified as Orchard.

In coastal Syria, the main classification problem was an overestimation of the Range category at the expense of Orchard and Extensive Agriculture. Terrace development is more widespread than was realized during the brief, initial field trip in November 1978, which predisposed the interpreters to underestimate Extensive Agriculture and Orchard developments. Changes in land cover since 1972 (when the EROS Landsat image for this area was acquired) have been substantial, again leading to an underestimation. A further problem was encountered in coastal Syria which is also present elsewhere in the country. The tones on the imagery created by small trees and brush vegetation which should be classified as Forest or Orchards merge into those associated with Range, so that in some instances, orchards with young trees and newly reforested areas have been classified into the Range category.

Areas field checked from the Palmyra location were consistent with the preliminary interpretation. The agriculture in the scattered cultivated fields within the Steppe, especially in the immediate Palmyra vicinity, is based on ground water irrigation. The southwestern part of Syria, including the Damascus area, was also consistent in all the categories except Urban which appears to have been underrepresented.

A second major result of the field work was a modification of the descriptions that accompany the classification system. The categories were not changed, however, the exclusivity of some of the descriptions could not be verified in the field. The final classificaiton scheme, with modified descriptions denoted with a plus sign (+), are as follows:

Generalized Land Cover/Use Classification
for Syria

+1. Intensive Agriculture--areas of major irrigation development, offering the potential for multiple cropping

+2. Extensive Agriculture--indicates areas normally with a single crop, usually but not exclusively, non-irrigated

3. Range--indicates areas where the potential natural vegetation is predominantly grass-like plants, forbes, or shrubs that can be used for grazing

4. Water--indicates areas covered in water yearround--oceans, lakes, reservoirs, and rivers
5. Urban--indicates areas of intensive use with much of the land covered by man-made structures
+6. Forest--indicates areas of deciduous, coniferous and mixed forest
+7. Orchards--indicates areas of cultivated fruit, olive, and nut trees
8. Barren--indicates areas of land with limited ability to support plant life and less than one-third of the area covered in vegetation.

Final Mapping

The final mapping was completed in two stages. Using field data and ground photography acquired in July 1979, a reinterpretation of the problem areas was undertaken. A greater familiarity with the field situation and a reprocessing of the Telespazio imagery allowed a more precise delineation of the categories.

When the problem area reinterpretations were completed, the land cover/use map for all of Syria was systematically reviewed with both sets of imagery to check that no interpreter or cartographic errors remained in the map. This final interpreted working map was then used for fulfill two SASA project requirements.

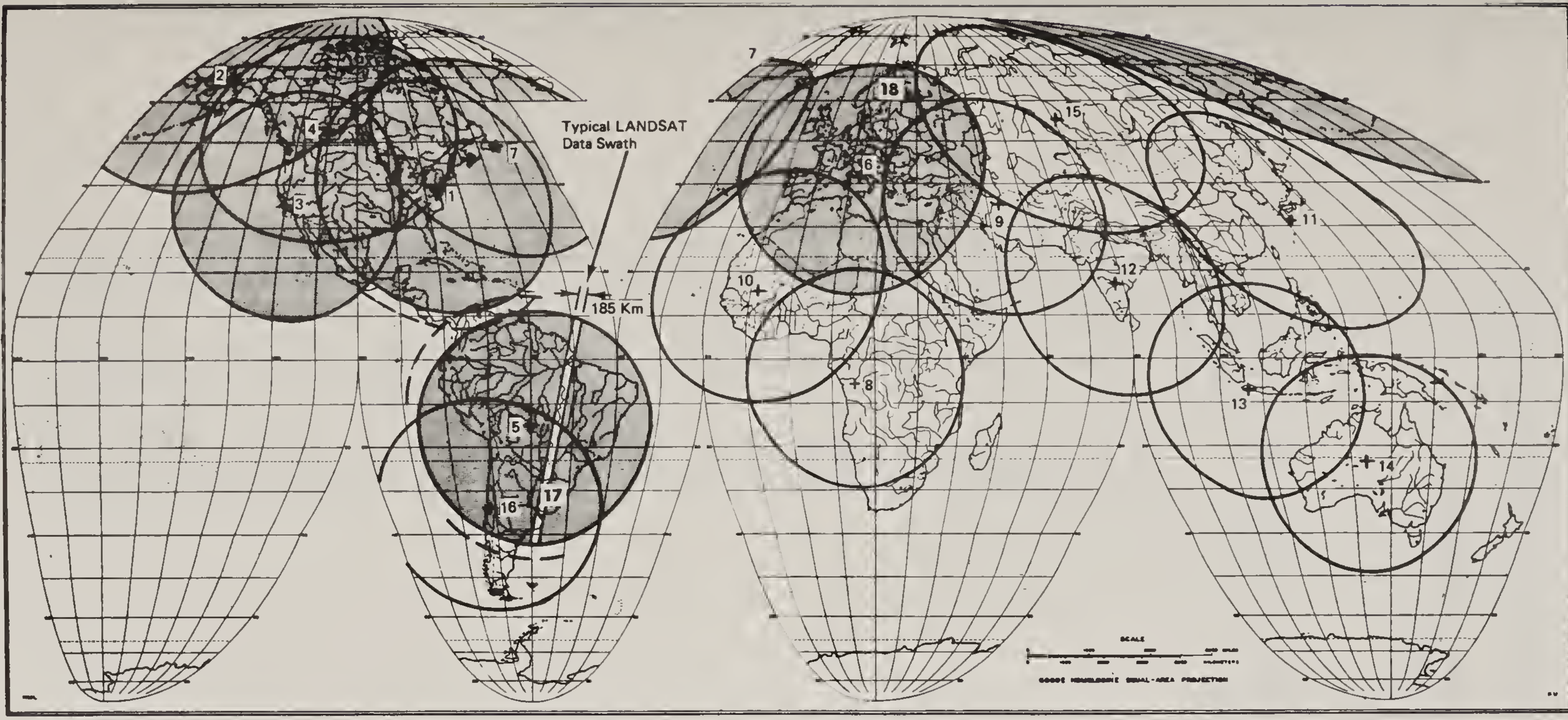
The final working map was geocoded to update the preliminary land cover/use data and provide a geographically-referenced, computer-compatible record of the final land cover/use interpretations for Syria. From this geocoded information area totoals of the land cover/use categories have been produced and these totals have been cross-tabulated with Resource Planning Units. A discussion of this information can be found in the conclusions of this report.

Concurrent with the final mapping effort, black and clear mylar base maps of the 1:200,000 Syria topographic series were prepared. The final land cover/use map was segmented to match these maps and the delineated land cover categories were transferred to them. This is the final map product of the Land Cover/Use Inventory Team. As a result of irregularities in the preparation of the 1:200,000 Syrian topographic map series and the necessity of generating base information from unstable paper copies of these maps during the project, lines representing thematic land cover/use information will not always match on adjacent map sheets. Individual overlay sheets should not be panelled together.

Table 1.--Landsat Imagery Purchased from EROS Data Center

Scene ID	Path	Row		False Color Composite 18.5cm	Black & White Transparencies 18.5cm	Black & White Transparencies 55.8mm
8220907111500	184	34	Aug. 19, 1975	x	x	
8148307224500	184	37	Nov. 18, 1973	x	x	x
8222807165500	185	34	Sep. 7, 1975	x	x	x
8222807171500	185	35	Sep. 7, 1975	x	x	x
8215607185500	185	36	Jun. 27, 1975	x	x	x
8215607191500	185	37	Jun. 27, 1975	x	x	x
8255307163500	186	35	Jul. 28, 1975	x		
8215707243500	186	36	Jun. 28, 1975	x	x	x
8223007284500	187	35	Sep. 9, 1975	x	x	x
8105407412500	187	36	Sep. 15, 1972	x		
8223007293500	187	37	Sep. 9, 1975	x	x	x
8222707110500	184	34	Sep. 6, 1975		x	
8208307121500	184	34	Apr. 15, 1975		x	x
8220907113500	184	35	Aug. 19, 1975		x	x
8146507222500	184	36	Oct. 31, 1973		x	x
8208407175500	185	34	Apr. 16, 1975		x	x
8258907150500	186	34	Sep. 2, 1976	x	x	x
8212107232500	186	34	May 23, 1975		x	x
822290722500	186	35	Sep. 8, 1975	x	x	x
8215707250500	186	37	Jun. 28, 1975		x	x
8215707252500	186	38	Jun. 28, 1975		x	x
8214007292500	187	34	Jun. 11, 1975	x	x	x
8210407292500	187	34	May 6, 1975		x	x
8223007290500	187	36	Sep. 9, 1975		x	x

Table 2.--Receiving Stations for Landsat Data.



Country	Map Number	Location	Present Status
USA	1	Greenbelt, MD	Operational
USA	2	Fairbanks, AK	Operational
USA	3	Goldstone, CA	Operational
Canada	4	Prince Albert, SASK	Operational
Brazil	5	Cuiaba	Operational
Italy	6	Fucino	Operational
Canada	7	Shoe Cove, NFLD	Planned, operational date undetermined
Zaire	8	Kinshasa	Undetermined
Iran	9	Tehran	Operational
Mali	10	Maitounke	Undetermined
Japan	11	Ohasi	Operational
India	12	Hyderabad	Planned, operational by late 1979
Indonesia	13	Djakarta	Undetermined
Australia	14	Alice Springs	Planned, operational by March 1980
USSR	15	Tomsk	Undetermined
Chile	16	Santiago	Undetermined
Argentina	17	Mar Chiquita	Planned, operational by April 1980
Sweden	18	Kiruna	Operational

Source: Based on the Committee on Remote Sensing for Development, 1977.

Table 3.--Landsat Imagery Purchased from Telespazio

(All images are black and white transparencies of 18.5cm format. No scene ID numbers are available.)

PATH	ROW	DATE
183	34	Feb. 4, 1978
184	34	May 23, 1978
184	34	Sep. 8, 1978
184	35	Feb. 4, 1978
184	35	May 23, 1978
184	35	Sep. 8, 1978
184	36	Feb. 4, 1978
184	36	May 23, 1978
184	36	Sep. 8, 1978
184	37	Feb. 4, 1978
184	37	May 23, 1978
184	37	Sep. 8, 1978
185	34	Feb. 5, 1978
185	34	May 24, 1978
185	34	Sep. 9, 1978
185	35	Feb. 5, 1978
185	35	May 24, 1978
185	35	Sep. 9, 1978
185	36	Feb. 5, 1978
185	36	May 24, 1978
185	36	Sep. 9, 1978
185	37	Feb. 5, 1978
185	37	May 24, 1978
185	37	Sep. 9, 1978
186	34	Feb. 24, 1978
186	34	May 25, 1978
186	34	Sep. 10, 1978
186	35	Feb. 24, 1978
186	35	May 25, 1978
186	35	Sep. 10, 1978
186	36	Feb. 24, 1978
186	36	May 25, 1978
186	36	Sep. 10, 1978
186	37	Feb. 24, 1978

PATH	ROW	DATE
186	37	May 25, 1978
186	37	Sep. 10, 1978
186	38	Feb. 24, 1978
186	38	May 25, 1978
186	38	Sep. 10, 1978
187	34	Feb. 25, 1978
187	34	May 26, 1978
187	34	Sep. 11, 1978
187	35	Feb. 25, 1978
187	35	May 26, 1978
187	35	Sep. 11, 1978
187	36	Feb. 25, 1978
187	36	May 26, 1978
187	36	Sep. 11, 1978
187	37	Feb. 25, 1978
187	37	May 26, 1978
187	37	Sep. 11, 1978

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Syria: Agricultural Sector Assessment

Volume 2: Natural Resources Annex

CHAPTER II

WATER RESOURCES

Based on the work of

Clyde E. Stewart

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PREFACE

The main objectives of this study were to inventory and describe Syria's existing surface and ground water supplies, stream flows, principal dams and current water utilization patterns, and to identify potential areas for expanded irrigation. Current water utilization policies were to be assessed and modifications proposed which might increase the efficiency of water resources use.

A major sub-objective of this study was to compile water resources data in such form that it could be used in an analysis of the agricultural economy of Syria. While the data that were made available for this study have been included in this report, they are often presented in summarized form due to the detailed nature of the basic information. These detailed sources of data, such as statistics on water supplies from reservoirs, springs and wells, and more than 30 maps related to water resources in Syria, have been placed in the technical files of the Agricultural Sector Assessment project. These files also contain forms and procedures that can be used to estimate the present water and the magnitude of present water shortages in the irrigation network and hydrologic basins of Syria.

The author expresses special appreciation to Bassam Kasatly, Anan Khalil and Abdul Fatah Muski, Ministry of Public Works and Water Resources, for their continuing assistance throughout this study. He is also deeply grateful to many others who assisted with their knowledge and information about water resources of Syria.

WATER RESOURCES

A. Introduction

The agricultural strategy of the Fourth Five-Year Plan places major emphasis on the development and utilization of the nation's water resources. In order to increase the volume and stability of agricultural production, the area of irrigated land is to be greatly extended through maximum use of water resources, chiefly in the Euphrates Basin but also in other regions. Also the use of irrigated lands for agricultural production is to be intensified to a ratio of 160 percent. In addition to crops, water resources development is required in order to meet national goals for improved drinking water supplies throughout the country, both for humans as well as for livestock. Improved environmental quality can also be achieved through better quality of water, recreation facilities, reduction of salinity, and reduction of erosion and sediment.

The Physical Setting

Water resources and their use are closely related to the soil characteristics and rainfall patterns found in the various regions of the country. As reported in the Statistical Abstracts, soil groups are described as follows:

1. Red Mediterranean (600 mm rain, clay loam and loam, cropped)
2. Grumosol (300-600 mm rain, clay, wheat belt, irrigated, good for cotton)
3. Cinnamonic (150-300 mm rain, loam and clay loam, calcareous, interior plains, barley)
4. Desert (Steppe, grazing, highly calcareous)
5. Gypsiferous (erosive, crust, irrigation only)
6. Alluvial (low valleys, Euphrates, sand loamy to clay, irrigated cotton)
7. Groundwater

On the basis of area, soil groups 3,4, and 5 are substantially the largest, comprising 78 percent of the total land area of Syria. It can also be noted that the Euphrates Basin soils are largely group 5 - Gypsiferous.

Based primarily on rainfall, the country has been divided into five stabilization zones or agricultural areas. As given in the Statistical Abstracts, the main characteristics of these zones are as follows:

1. Rainfall over 350 mm annually

   a. 600 mm and over - successful crops without irrigation.

   b. 350 to 600 mm and not less than 300 mm during 2/3 of the related periods (i.e., two crops possible in three years) - main crops wheat, pulses and summer crops.

2. Rainfall 250 to 350 mm and not less than 250 mm during 2/3 of the related periods - barley, wheat, pulses and summer crops.

3. Rainfall averages over 230 mm and not less than this during half of the related years (i.e., one or two crops possible during three years) - barley the main crop.

4. Rainfall averages 200 to 250 mm and not less than 200 during half of the related periods - marginal for crops, good grazing land.

5. Desert or steppe - not suited for nonirrigated agriculture.

Water Resources Agencies

The major public water development programs in Syria are under the Deputy Prime Minister for Public Services. The main component of Public Services is Water Resources and Land Reclamation, and in turn, the Ministry of Public Works and Ministry of Euphrates Dam. The other component is Domestic Water Supply which is comprised of the Ministry of Housing and Utilities.

The main organizations units are as follows:

Ministry of Public Works and Hydraulic Resources

1. General Administration of Major Projects
   - A. Water Development
     - (1) Directorate of Technical Affairs
   - B. Water Resources
     - (1) Directorate of Hydrologic Basins

2. Directorate of irrigation and hydraulic power
   - A. Water Development
     - (1) Bureau of Dams
     - (2) Bureau of Irrigation
   - B. Water Resources
     - (1) Bureau of Surface Water
     - (2) Bureau of Ground Water

3. Directorate of Public Water Antipollution
    A. Water Development
        (1) Technical Bureau
    B. Water Resources
        (1) Laboratory

<u>Ministry of the Euphrates Dam</u>

1. General Administration of Euphrates Dam
    A. Water Development
        (1) Direction of Technical Studies
    B. Water Resources
        (1) Direction of Water Resources Studies

2. General Administration of Euphrates Basin Development
    A. Water Development
    B. Water Resources

<u>Ministry of Housing and Utilities</u>

1. Directorate of Water Supply
    A. Water Development
        (1) Bureau of Technical Studies
    B. Water Resources
        (1) Bureau of Water Resources Studies

Other ministries involved in the use and development of water resources include the Ministry of Agriculture and Agrarian Reform, the Ministry of Industry, and the Ministry of Defense. Agriculture is especially involved in the distribution and use of water, particularly in Ghab Project Area. Industry is concerned with the industrial uses of water and the meteorology program is in Defense.

In addition to the Central Government Offices, most ministries have offices at Mohafaza, Basin and Project levels; also in Mantikas and villages in some instances.

<u>Water Resources Projects</u>

Numerous development projects are being executed by, or under the direction of, the government's various water resource agencies. Major characteristics of these projects, which vary considerably in both objectives and size, can be summarized as follows:

Euphrates Basin

The Euphrates irrigation project is generally described as comprising 640,000 hectares, and one estimate of the net irrigated area is 560,000 to 580,000 ha However, estimates of the area often vary from one reference to another. For example, differences exist as to whether or not the Lower Khabour area is a part of the project, although seemingly it would have to be included for a total of 640,000 ha. Uncertainties about the area to be irrigated probably arise because of the serious gypsum and salinity problems encountered to date in construction and in agricultural production.

One estimate of the total area, by sections, is as follows:

	Hectares		Hectares
Meskeneh	155,000	Lower Euphrates	175,000
Balikh	185,000	Meyadine Plain	40,000
Rasafeh	25,000		
Lower Khabour	70,000	Total	650,000

The current Five-Year Plan has targets of 240,000 ha to be prepared for irrigation and 135,000 ha to be under cultivation by the end of 1980. These goals do not seem attainable now. Apparently an earlier overall goal was to complete development and have under irrigation the 640,000 ha by the year 2000. This goal seems increasingly unrealistic as time moves on, although there seems to be some opinion that development will soon reach 30,000 ha per year.

Various studies have shown the project to be technically and economically feasible. Obviously, since the dam has been completed, the economic viability of the total project rests now on the development of the agricultural phase of the project. Experience suggests the critical need for pre-development of the land, the farm distribution systems, and the major and farm drainage systems before commencement of irrigated agriculture. The rapidity with which these measures are accomplished will determine the near future success of the project.

In addition, examination of land classification data on about 400,000 hectares is of some concern, see Tables 1 and 2 at the end of the text. Presumably this classification is the basic system of the U.S. Bureau of Reclamation. In this case, Class IV is marginal at best for irrigated agriculture. Since only 64 percent of the land is in classes I through IV, and 48 percent is classes I through III, this suggests that less than half of the 640,000 hectares is reasonably good land for irrigation purposes.

Several other major problems need to be resolved, including production of raw materials for two or three sugar factories and a plywood mill, kinds of settlements and farming systems to be established and financing of investments and annual operation cost. The role of farm organizations and the level of management also influence how the problems are solved. Employment opportunities, mechanization, volume of production, and level of incomes all hinge on these decision.

Ghab Redevelopment

A French consulting firm is currently conducting a study on "redevelopment" of the Ghab Valley. The main elements of this study are to alleviate flooding of 15,000 ha of cropland during the rainy season and reduce drainage problems elsewhere in the valley, and to exploit springs by pumping their supply during irrigation season and reducing the losses to the sea during winter months. Ghab Valley also requires land leveling and field drains.

Water Basin Studies

Study of groundwater and surface water is being carried out under a five year contract (1974-79) with the Soviet Union in the Damascus, Orontes, Coastal, and Aleppo Basins. Special emphasis is to be given to groundwater and a program of test wells has been conducted in the Basins. Reportedly this information is being analyzed with a delayed report forthcoming possibly in 1980.

Indications are that a second contract has been made with the Soviets for 1979 and 1980. It is concerned with planning the use of all water resources. The Water Resources Directorate in Homs will follow up on this contract, and projections will be made of all water consumptive uses for the next 20-25 years.

Kremish Dam

A French study is approaching final design stage for this proposed 275 million m^3 dam and reservoir on the Orontes river upstream from Hama. This storage water would be utilized for irrigating a large portion of the irrigable land remaining in the Ghab Valley System.

Saroute Dam

A small dam is proposed on the Saroute river, a tributary to the Orontes River above Mehardeh reservoir.

Afrin River Dam

This river is also a tributary to the Orontes from the north, but involves an area outside the Ghab Valley. A French study of this proposal is in process. A dam near Medante with a capacity of 230 million m^3 would supply irrigation water to 20,000 ha

Al-Khabour

A Bulgarian study on development of the Upper Khabour proposed two dams with capacities of 600 million m^3 and 320 million m^3, plus some pumping and groundwater development. Some gypsum problems were encountered in the area to be served by the Lower Dam. This study also proposed introduction of sprinkler irrigation. The Water Basins Administration has recently initiated a supplemental test well drilling and laboratory program in this area.

Akkar Plain

This development is to provide surface and groundwater to 23,000 ha of irrigated land. A feasibility study of the proposed agricultural development was favorable to the project. However, a separate study of reservoir sites and construction by a French firm reportedly shows that storage on the Arouse river is physically feasible and, while storage on the Abrach river may be physically feasible, the prospective costs are excessively high.

Al-Kabir Al-Shamali (North Great River)

This proposal involves a dam near Lattakia with a capacity of 214 million m^3 irrigate 14,000 ha of land south of Lattakia. A Russian firm is in the final stage of design of the dam. However, the irrigation and economic potentials have not yet been studied and appraised; the Russian contract contains a provision for this study.

Al-Kabir Al-Janubi (South Great River)

Consideration has been given to possible construction of a dam and reservoir with capacity of 150 million m^3 on this river. Apparently litte has been done beyond the proposal stage.

B. Water Supplies

Water data are usually presented in Syria within the context of seven major basins: Upper Jordan, Damascus, Orontes, Coastal, Aleppo, Middle Euphrates, and Steppe. These basins, which are shown in Figure 1 at the end of the text, are variously given other names in other documents. This same map also delineates 15 hydrologic sub-basins within the major basins, and 20 public irrigation networks. Ground water basins are also identified. Water resource data and summaries in this section utilize these basic delineations.

River and Streams

The long-term average annual quantity of water in streams and rivers in Syria is quoted at 32 billion m^3 of which 27 billion m^3 is in the Euphrates River. In contrast, the estimated annual quantity of rainfall is 50 billion m^3.

The flow of the Euphrates the last seven years has averages substantially less, however, about 22.1 billion m^3; measurements at the Syrian-Turkish border. However, even this lower quantity is about double the storage capacity of the Lake Assad. The published statistics do not show whether the Euphrates River measurements include the flow of Al-Khabour River, its major Syrian tributary.

Annual flow data point up another significant water supply element: Stream flows fluctuate widely from year to year (Table 3). The other major stream, the Orontes, in the past 7 years ranged from an average of 25.0 m^3/sec to 50.0 m^3/sec. The Barada river flows ranged from a 2.4 m^3/sec annual average to 11.0 m^3/sec. Especially where there is no storage for carryover purposes, these fluctuations are no doubt serious for agricultural production. Table 4 shows also the minimum and maximum flows for the years 1967 and 1973 thru 1977. In 1973 and 1974, the Orontes flow approached zero as minimums.

A large portion of the rivers in Syria have their origin outside of the country (Table 5). The Euphrates, Jaghjagh, Orontes, Afrin Queiq, Kabir-Shamali, and Yarmouk are in this category. This situation can have serious international implications for water resources development.

The main bodies of water are shown in Table 6 although Lake Al-Assad and Qattineh Lake are the only two on this list of particular importance from the water supply and use standpoint. Originally a lake, Qattineh has since been enlarged and is used primarily is an irrigation storage reservoir. The other two major bodies of water are formed by storage dams at Rastan and Mehardeh; these reservoirs will be discussed later.

Stream Flow Characteristics

In order to describe more fully the characteristics and location of water supplies with reference to irrigated agriculture, available data on stream flows were obtained from the Ministry of Public Works. Although in some cases the data have not been reported to the Ministry on a consistent or complete basis, a sample of 15 gauging stations was selected, see Table 7. The stream flows were summarized for these stations, along with readings on 5 streams for published sources. These 20 readings involve 13 rivers and streams, see Table 8.

Conclusions about total water supply cannot be drawn in several instances, especially for the Orontes and the Khabour because of the effect of withdrawals on total flows. The influence of discharges from springs is also reflected in most measurements in varying degrees.

However, station 2 should indicate the supply available downstream in the Barada. A similar indication holds for other rivers and streams except, primarily the Orontes, where storage interrupts the natural hydrology.

The data in Table 8 for each stream totals 4.26 billion m^3 versus an oft-quoted total stream flow in Syria of 5 billion m^3 without the Euphrates. Recognizing diversions especially for the Orontes and the Khabour, the two estimates are similar.

One significant point in the readings is the indication from station No. 7 that a substantial quantity of water leaves the Orontes Basin for the sea. It is also apparent that stream flow is particularly low in July and August on most streams. The regulatory effect of reservoirs is evident by the higher July-August portion below Mehardeh Dam - Station 6. The impact of summer use is further reflected in the low July-August portion leaving the Orontes Basin - Station 7.

While not necessarily typical, monthly flow quantities for 1976 point up significant features of water supplies in streams and rivers, see Table 9. For most streams, the large flow months are January through May. The lowest months vary somewhat with the Basin. The coastal streams are very low from July through November while October and November are the low flow months in the Barada.

The Orontes River shows a somewhat different pattern, partly as influenced by storage and heavy summer irrigation use. But the flow of the Orontes above Qattineh Reservoir is very uniform for all months of the year, Station No. 4. Station No. 5 below Qattineh follows a different pattern with high readings during the summer irrigation season.

In a similar manner, station No. 6 shows high readings in July and August when water is released for irrigation in the Ghab Vally. And finally, Station 7 at the lower end of the vallcy, has high flows during winter months as a combination of rainfall and non-use of springs and stream flow for irrigation.

Reservoirs

Reservoirs in Syria are classed according to several criteria, including: type of water resource (permanent/temporary), capacity of the reservoir, and height of the dam. The orgainzations responsible for dams are the Ministry of Public Works and Water Resources, the Major Projects Administration, and the Ministry of the Euphrates Dam.

Euphrates Dam

The capacity of the Euphrates dam and reservoir is about 12 billion m^3 of which 7.4 billion m^3 is live storage. As noted earlier, the annual runoff of the Euphrates River in Syria is about 27 billion m^3. The storage water is and will be used for power generation, irrigated crop production, and domestic water, mainly for Aleppo and settlers of the p roject.

Eight generators are installed for power generation of 100 megawatts each. Power is being distributed over most of Syria; demand is currently less than supply capacity. In March 1979, four generators were operating. Full operation of the 8 generators would require about 20 billion m^3 of water per year.

Evaporation losses on Lake Al-Assad are estimated at 1.3 billion m^3 per year.

Hydrologists have estimated that the water supply in the river will be adequate to meet irragation water needs under full project development.

Medium Dams

The number of medium sized dams in Syria is subject to a modification of the earlier definitions. One dam that qualifies in size, the Qattineh Lake Dam, is under the Ministry of Public Works. A small dam and reservoir, Tel Daou on a tributary to the Orontes above Rastan Dam, is under the Major Projects Administration and is listed as a medium dam in the Statistical Abstract. The Qattineh dam is not listed as a dam in the Statistical Abstract.

These dams are all in the Orontes River Basin and their storage capacities, in million m^3, are as follows: Rastan - 225; Qattineh - 200; Mahardeh - 50; Tel-Daou - 15.

Storage water from these dams is used for irrigation in the Orontes River Basin. Electric power is generated at Rastan and Mahardeh. The Rastan dam is also used to maintain a minimum flow for sewage disposal. Releases from these reservoirs for whatever purposes are, of course, reflected in the stream flow measurement discussed in the earlier section.

Small Dams

In addition to the five larger reservoirs, the Ministry of Public Works has identified 60 small reservoirs in Syria. All 65 reservoirs are located and summarized by hydrologic basins in Table 10. Similarly, 20 small dams under construction have also been summarized by hydrologic basin.

In summary, the total storage capacity of the 65 completed dams is 12,638 billion m^3, of which 12.0 billion m^3 is behind the Euphrates dam, see Table 10. The 60 small dams have a total capacity of 148 million m^3, or 2.47 million m^3 average per dam. The 20 small dams under construction average 4.92 million m^3 per dam.

About one half of the small dams, or 34, were completed in 1967 to 1969, and about one fourth, or 17, have been completed since 1970, see Table 11. The Euphrates dam, of course, is fairly recent. The medium dams in the Orontes basin are 17-20 years of age. Twenty three dams are planned and expected to be executed in 1979-1981, see Table 12. Six of these dams are in Jezireh Basin and 7 dams are in the Coastal Basin. These 23 dams average 4.75 million m^3 capacity.

A crucial element in water storages, of course, is the extent to which they can be filled each year. Apparently the intent has not been to fill the Euphrates dam at least through 1977, when reports showed it 63 percent filled. In 1978, the medium dams in Orontes Basin filled 100 percent. However, 57 small dams for which data are available were filled only to the extent of 53 percent, Table 13. Some small reservoirs reportedly stored no water and several others were less than 25 percent. The 6 reservoirs in the Coastal Region filled completely. While not complete for all dams, data available through 1977 show low water supplies for a a large number of reservoirs each year, Table 14.

The purpose for which the reservoirs have been or will be constructed are shown in Tables 15 and 16. About one third, or 21 reservoirs were constructed for irrigation only. Their average capacity was 3,074,000 m^3. Five slightly smaller reservoirs, averaging 2,576.000 m^3, are solely for flood control. And 24 reservoirs averaging 1,208,000 m^3 are for domestic use only. Nine reservoirs averaging 2,898,000 m^3 are for combination irrigation-domestic purposes, and the six largest reservoirs are combination irrigation-flood control; as noted earlier, three of the largest reservoirs and dams are also used for electric power generation.

A similar pattern of purposes is evident also for the 20 reservoirs under construction. Most of these reservoirs are for irrigation or irrigation-domestic purposes; they average somewhat larger than the reservoirs already constructed. Of 23 planned reservoirs, 1979-81, 7 are planned for irrigation and 10 for domestic purposes.

Diversion Dams

The Ministry of Public Works has constructed about 55 dams in the Yarmouk Basin for the purpose of diverting rain runoffs from otherwise largely dry channels onto tracts of crop land. However, these dams pose a dilemma. First, water is available only during a rainstorm when the crops do not need the water. Second, the dams prevent the water being available for storage in several small reservoirs in the Basin. A notable example is a reservoir at Dar'a where a large number of diversion dams upstream virtually keep dry a reservoir which was originally constructed to irrigate several hundred hectares of land.

Springs

Springs are highly significant in the supply and use of water resources in Syria. Data on the flow and location of 235 springs are show in Table 17. More than 70 percent of these springs are in the Barada, Orontes and Yarmouk Basins. Average flows of the springs range from 1 l/sec to 10,000 l/sec.

The total flow of 184 measured springs is 68,661 l/sec or 2.166 million m^3 per year. This quantity of water approaches one half the total measured streams other than the Euphrates; of course, a large portion of this spring water becomes a portion of the stream flows.

The average size of 184 springs, which are the larger springs, is 373 l/sec. The largest spring is Ras Al Ein, which is the main source of the Khabour River; this spring averages 40,000 l/sec, see Table 18.

In addition to the Sinn and Barada basins, springs are especially important in the Orontes Basin. The 59 springs in this Basin have been groupedgeographically on the basis of where they enter the Orontes River and storage system, see Table 19. These springs supply 25,252 l/sec average or 1.73 billion m^3 per year. Apparently this quantity of water could amount to one half or more of the total supply in the Orontes River Basin.

Volumes of spring flows fluctuate widely from year to year in most instances, Table 20. Of the major springs, Al Sinn is an exception with its fairly uniform total flow from year to year. The flow of all major springs is high in the early months of the year and then declines markedly around June and July for several months. (See Table 21 for recent measurements of major springs in the Damascus Basin).

Wells

Groundwater resources are immense and extremely important in Syria. The large number of springs and associated large volume of water were noted above. But thousands of wells also are available throughout the water basins for irrigation, livestock, domestic and industrial uses. River pumping is also important especially in the Euphrates River Basin.

Legally, licenses are required to drill and use wells. The licenses,which also specify the extent of use, are supposed to be renewed every 10 years, but it appears that a large portion of the wells are not licensed and that no particular attention is paid to use specifications. Licensing occurs at the local office level in the centers of the various Mohafazat . The Central office of Ministry of Public Works does conduct the drilling of test wells which are utilized in decisions about licensing of additional new wells. But the indications are that these test wells are not especially monitored after drilling to see whether the groundwater level is being depleted.

Agricultural statistics do allocate total irrigated crop land among sources of water, as shown in Table 22. However there may be some definitional questions. For example, if well pumping is used to supplement surface water supplies, how is the land classified?

While the lack of reliable estimates of water pumped for irrigation and other uses is generally recognized, large groundwater resources are indicated by various data on pumps, and on pumping licenses. Agricultural statistics report an increase in pumps used in cultivation from less than 27,000 in 1967 to 40,500 in 1976, see Tables 23 and 24.

About 8,500 of these pumps were in Damascus Mohafaza and nearly 10,000 in Aleppo. Homs and Hama combined accounted for about 8,600. In spite of the lack of supervision and enforcement, large numbers of pumping licenses have been issued over the past 20 years, see Table 25,26 and 27. From 1972 through 1977, more than 23,000 pumping licenses were issued in Syria for the first time or renewals. Nearly 10,000 new licenses were issued during the 6 years from 1972 to 1977.

Several authorities have asserted that groundwater supplies are being depleted, that is, annual extraction exceeds replenishment. This applies in several Basins and particularly in Damascus, Orontes, and Aleppo. At the same time many new licenses are being issued in these Basins. New licenses may be offset to some extent by expiration of old licenses and pumping may be discontinued in some cases.

The Ministry of Public Works has detailed information on more than 1,000 wells distributed over the country. This information includes date of drilling, depth of well, static water level, dynamic water level, yield in m^3/hour, chemical analysis, and aquifer. Selected information for a sample of these wells is given in Table 28.

The Water Basin Administration, under a contract with the Soviet Union, is nearing completion of a five-year study of water basins in western Syria. This program has included drilling of test wells. Apparently a computer program is being utilized in analyses of these data. The report is due within the next year or so. The Water Basin Administration has made available selected data about these test wells which are also mapped. These wells were drilled the last several years, see Table 29.

Water Quality

Water quality readings for selected stations and dates for the Barada River were supplied near the end of this study. They are presented in Table 30 for information purposes. A large-scale water quality map showing stations, industrial plants, etc. is contained in the files of the ASA project.

C. Water Utilization

The agricultural sector is the major user of water in Syria, with most of this water used for the production of irrigated crops. The nature and extent of water utilization for these crops, as well as for domestic and industrial purposes, are reviewed in this section.

Irrigated Crop Production

As reported in the Annual Agricultural Statistical Abstracts, the irrigated crop area, which includes double cropping, increased steadily from 457,000 ha in 1968 to 621,000 ha in 1977. Most of this increase was in winter crops, which increased from 107,000 ha to 232,000 ha. Irrigated fruit area rose from 40,000 ha to 52,000, and summer crops from 310,000 ha to 337,000 ha

From the standpoint of irrigated cropped area, the most important Mohafazat in 1977 were Deir-ez-Zor, Al-Hasakeh, Damascus, Aleppo and Al-Rakka. The Damascus Mohafazat contains about 52 percent of the irrigated fruit land. About 23 percent of the summer crops are vegetables, while only 8 percent of the winter irrigated crops are in vegetables.

The irrigated wheat area has increased consistently and nearly tripled since 1968; irrigated wheat has been mostly of the Mexican wheat variety since 1973. The total area in cotton production has been less the past several years than during the late 1960's and early 1970's. Similarly, the hectares of sugar beets havebeen less in recent years in spite of the apparent effort by government to increase sugar production. Irrigated areas in maize, sesame, peanuts, and tomatoes have increased also over the past 10 years.

A large portion of irrigated cotton production is in the Ghab, Aleppo, Al-Hasakeh, Al-Rakka and Deir-ez-Zor Mohafazat. Sugar beets in 1977 were produced mainly in Damascus, Homs and Hama. Irrigated wheat is largely in Aleppo and the eastern Mohafazat. Irrigated vegetables are produced in most Mohafazat.

A wide variation in irrigated crop yields was reported among Mohafazat . Wheat yields ranged from 1,532 kg/ha in Tartous to 3,034 kg/ha in Idleb. Cotton yields ranged from 1,755 kg/ha to 2,633 kg/ha. Likewise, sugar beets ranged from 23,445 kg/ha to 34,916 kg/ha; in terms of sugar beet production worldwide , these yields are all low. Irrigated tomato production in 1976 ranged from 11,000 to 28,000 kg/ha among Mohafazat. The reasons for these yield differences may be a worthwhile area of investigation.

Irrigated Area

The total area under irrigated crops has shown a nearly continuous decline from 625,000 ha in 1972 to 519,000 ha in 1978. However, projects now in various stages of planning or construction to be completed by 1985 will add an additional 34,600 ha.

In 1978, essentially all of the non-pump irrigation area came from rivers, springs and flood irrigation and totalled 102,500 ha. In the same year the pump irrigation area totalled 416,500 ha, of which 216,000 ha were from wells and 200,500 ha were from rivers.

The irrigated area in 1978 by Mohafazat was as follows, in thousands of ha:

Damascus	73	Al Hassakeh	82
Aleppo	72	Al Rakka	42
Homs	41	Al Sweida	--
Hama	63	Dar'a	9
Lattakia	18	Tartous	18
Deir-ez-Zor	86	Quneitra	1
Idleb	14		
		Total	519

Source: Statistical Abstract, 1979.

Irrigated Versus Rainfed

Irrigated crop production in Syria overall takes second place to rainfed crops. But when fallow land, crop intensities, yields, and industrial crops are considered, the difference becomes relatevely less. In fact, in terms of metric tons of all production, the percentages are 57-43 in favor of non irrigated.

Irrigation is relatively unimportant in winter crop production, although 49 percent of irrigated crops are of the winter category. Twelve percent of all wheat land and 46 percent of Mexican wheat land are irrigated. Otherwise only a few vegetables such as cabbage and cauliflower are relatively important winter crops, see Table 31.

As to summer crops, irrigated maize, cotton, sesame, sugar beets, peanuts, tomatoes, potatoes, and cucumbers are important, both relatively and absolutely. Among fruits, irrigation is important in production of apricots, nuts, apples, pomegranates, and citrus.

However, because of higher yields the relative importance of irrigation is considerable greater from a production standpoint, see Table 31. In addition, certain irrigated crops take on a greater significance, not only because of their value, but also because they provide raw material inputs to industrial activities, such as cotton and sugar beets. While cotton hectarage has declined in recent years, total production has increased substantially. The performance in sugar beets has been less consistent. Production of irrigated tomatoes, potatoes, and wheat has increased markedly in the past 10 years. These irrigated crops take on added significance as one looks at the potential new irrigation in the Euphrates Basin where cotton and sugar beets are planned for major expansion.

Crop Production Intensity

Irrigation is important from a production standpoint, not only because of its higher-yielding and higher-valued crops, but also because of the more intensive cropping pattern that is feasible. Improvement in the crop intensitiy rate becomes a major goal in the use and development of water resources.

In 1976, 4.1 million ha of land were used for crop production in Syria. Fifteen percent of this crop area, or 62,000 ha, was irrigated. But crop production on 3.4 million hectares of rainfed land also required about 1.3 million ha of fallow land. Thus, the crop intensity ratio (CIR) on non irrigated land was only 66 percent. In contrast, the CIR on irrigated land was 115 percent.

With an adequate water supply, the feasible level of crop intensity is considerably larger. In fact, the CIR on irrigated land is considerable higher, especially where vegetables are important, see Table 32. The CIR in Tartous was 161 in 1976, and 131 in Homs. But the most important irrigated Mohafazat were in the range of 100 to 120 percent.

Canal Networks

The Ministry of Public Works supplied information about the various canals in irrigation networks of Syria. No analysis was made of these data as they were received after completion of the draft report. This information is presented in Appendix A.

Water For Livestock

While no data are available on water used for livestock production, an estimate can be made using the rates applied in a U.S. study: 20 gallons per day (gpd) for milk cows, 10 gpd for beef animals, 10 gpd for horses, 2 gpd for sheep, and 2 gpd for goats. Based in these rates, the daily consumption would be 24.6 million gallons, and 8,979 million gallons per year. This quantity amounts to 34 million m^3 per year. This volume is the equivalent of several small reservoirs. The Ministry of Agriculture supplied information on 71 wells in the Steppe with a yield of 511 m^3/hr; if operated continuously, 116 million m^3 could be pumped from these wells in a year. This extent of pumping is unrealistic, however.

Domestic Water Use

Consumption of water for domestic use is directly related to population. In 1977, the estimated population of Syria was 7.8 million, of which 4.1 million were rural. About 45 percent of the total population lives in Damascus and Aleppo Mohafazat. . Projected population for Syria in 1990 is 11.9 million, or 152 percent of 1977. The percentage distribution among Mohafazat remains about the same in these projections although in numbers, the projected increases in Damascus and Aleppo Mohafazat are substantial, reaching 3.2 and 2.4 million, respectively.

The present production of water for drinking purposes is about 213.4 million m^3, Table 33. Slightly more than half of this amount is in Damascus and Aleppo. About one-fourth of the water is lost in transport.

A little more than half of the water is actually priced in the consumption process. The price of water in Damascus was 20 Syrian Piasters/m^3 through 1979, and since then has been 25 Syrian Piasters/m^3. Other charges occur with purchase of water, installation, transfers of rights, etc. A 1977 analysis estimated the long-term marginal cost of water in Aleppo at 10 percent discount rate at 1.10 Syrian Piasters/m^3.

One estimate indicates that about 60 percent of the drinking water in Syria comes from wells and 40 percent from lakes, rivers, and springs. Since Aleppo obtains its water from Lake Al-Assad and Damascus from a spring, it may be that the lakes, springs and rivers figure is somewhat larger than 40 percent.

A great need exists for sewage treatment plants in Syria. Collector systems now discharge into rivers, valleys, irrigation fields or the sea. Several river system, especially the Barada, are highly polluted. If several projectons prove to hold, the future will place even greater demands on the systems. Aleppo has a new 220,000 m^3/day line from Lake Al-Assad, and the Damascus system is being enlarged. But one estimate shows the projected consumption in urban areas to increase from 106 million m^3 in 1970 to 788.4 million m^3 by year 2000. This estimate is based on a population for Syria in 2000 of 16.8 million and an increase in per capita consumption from 55 LCD to 100 LCD in 2000.

Studies of sewage system proposals are being made for Damascus, Homs-Hama, Aleppo and Lattakia. Financing will be a major problem in these projects and in other cities. The investment costs and annual operation and maintenance costs for drinking water and sewage plants will have to be met in part by a system of charges to consumers and users.

Industrial Water Use

Under the Ministry of Industry an extensive program of industrial development is under way, much of it involving agricultural processing and related industries. Good progress is reported on the present Five-Year Plan proposals, but because of labor and materials shortages, plants are and will likely be operating at only 50 percent capacity. Present views seem to be to minimize new plant construction in the next five-year plan and concentrate on achieving capacity operations of the existing facilities.

A large number of industries require substantial amounts of water either for consumptive use or other purposes. Lack of water or provision of water occasionally is a major obstacle; this problem seems to have occurredin the Damascus area about as frequently as anywhere. In other areas, especially Homs-Hama on the Orontes and in the Euphrates Basin, river water seems to be readily available. However, full development of the Orontes for irrigation might pose a problem in the future unless careful planning is pursued.

The Ministry of Industry regularly studies proposed new industries and considers manpower, financing, transportation, markets, people, raw materials, water and power. Plans include enlargement of steel pipe facilities at Hama, a plastic plant at Aleppo, three yeast plants, a cement plant soon to open in Aleppo, cement plants under construction at Tartous and Aleppo, two glass plants soon to open in Aleppo, a paper plant to be ready in Deir-ez-Zor by the end of the year, and new fruit canning plants at Al-Hasakeh, Meridian, and Idleb.

Prominent water-using plants in Syria include steel plants, yeast plants, five sugar factories, plastic plant, cotton yarn plants, several cement plants (a recently adapted new process required little water), a paper-pulp mill at Deir-ez-Zor, four glass plants, ceramic plants, five manufacturing, and six fruit canning plants.

Apparently opportunities exist for water conservation and quality improvement through introduction of water recycling processes where appropriate. The Ministry of Industry reportedly is considering this prospect.

Water Use Efficiency

Improvements in the efficiency of water distribution systems and on-farm and on-field management and application may be some of the more effective and low-cost ways to enlarge the water supplies in many areas of Syria. Irrigation experts frequently mention this problem. The need for renovation, and possibly new layout, of distribution systems, and improved management of water by farmers, including land leveling, field layout and method of irrigation, is evident in many areas.

However, the above efficiency measures do have some tradeoffs. Reduction of return flows from canals, ditches, and fields--either surface or percolation--means frequently that less water is available for springs and wells. Net disappearance of water may be low since the water returns to groundwater supplies. In part, the question becomes one of alternative costs plus any institutional constraints in relocating the application and consumptive use of the water.

Also, timing becomes important when canal losses, for example, go into groundwater reservoirs and return later as springs. Water lost in summer use may return through springs too late to be useful during the growing season. And the availability of water also changes location.

The above efficiency measures may have at least one additional advantage, for example, in the Ghab Valley. By "saving" the water and using it for irrigation, although springs and wells may be adversely affected, the magnitude of water that escapes to the sea during winter months should be reduced. Especially is this so if storage reservoirs are available to hold the "excess" water.

The incentives that farmers have available to them are important to efficient use of water. Management, land leveling, lined ditches, etc. are important, but the farmer is more likely to respond if water charges are based on quantity of water used, and there is some flexibility in quantity and timing, and if farmers could use the water and grow the crops that would yield the highest income and result in improved water-use efficiency.

Consumptive Use

Information was not available on farm and field water use efficiencies, but several reports of estimated canal losses, and several contract feasibility studies estimated water requirements based on plant consumptive uses. While consumptive use and water requirements vary with complexity of soils, crops, cropping pattern, yields, temperature, precipitation, estimates made for several projects are shown in Table 34.

D. Water Development

Water resource development for increasing agricultural production in Syria continues to be directed toward the expansion of irrigated land area, as well as toward the intensified use of the irrigated areas. In this section certain problems affecting the implementation of this strategy, as well as potentials for new developments and improved efficiencies in water use, are reviewed and assessed.

Euphrates Irrigation Project

An essential step required for successful development of irrigated agriculture in the Euphrates project seems to be the rapid and complete pre-development of farm land, farm irrigation systems and drainage. This program apparently is planned, but it is not clear whether it will be fully carried out, especially at the farm level.

The "progressive" development of the Pilot Project may be expedient from the standpoint of an initial effort and as a training program. But many of the methods, such as small diked paddy production of sugar beets on unlevelled land, are hardly the way to successful sugar beet production.

The pre-development program should be accompanied by a rigorous education program for settlers and managers.

Also, in the development of the project's irrigated farming, the Administration is confronted by at least two possible problems relative to agricultural production goals. One is the extent of trade off between agricultural production and supplying employment opportunities. Basically this is the impact on production of mechanization and commercialization as compared with the use of a large amount of hand labor. The other major impact on goals may arise from indications that the area of land suitable for irrigated crop production may be substantially less than that originally included in plans and analyses, which was a gross area of 640,000 ha with an estimated 560-580,000 net irrigated ha. As noted earlier, a question exists as to whether suitable irrigated area occurs for much more than 50 percent of the total. Water allocated for irrigation is 7.5 billion m^3 or approximately 12,000 m^3 per hectare for plant consumptive use, leaching, and losses. In the Lower Euphrates Basin, where salinity is a serious problem, estimated water requirements are 17,000 m^3 per ha.

Major modifications in the above goals as originally conceived could also substantially affect the economic viability of the project.

Other Potential Irrigation Projects

Completion of several other projects and investments relative to water supplies and use should be pursued as economically and socially warranted and as plans and financing can be provided. Alternatives should be adequately considered both in decisions and in financing. Included in the potential projects are the following:

Major Projects Administration

a) Ghab redevelopment - drainage, flood control, and increased use of springs.

		Storage
b) Kremish Dam	28-30,000 hectares	275 Mm^3
c) Afrin 280 Mn^3 flow	20,000 hectares	230 Mm^3
d) Al-Khabour (1)	35,000 hectares	600 Mm^3
(2)	19,000 hectares	320 Mm^3
e) Akkar Plain	23,000 hectares	1/ 77-98 Mm^3
Abrache & Arouse rivers (110 Mn^3 flow)		
f) Al-Kabir Al-Shamali	14,000 2/	214 Mm^3
g) Al-Kabir Al-Janubi	10,000	150 Mm^3
h) Dams on Barada River		
i) Dams on A'waj River		

Ministry of Public Works		Storage
a) Small dams under construction	-20 3/	98.4 Mm^3
b) Small dams planned	-23 3/	109.2 Mm^3
c) Yarmouk irrigation (Der'a)	10,000 hectares	
d) Nasyrih irrigation (Homs)	15,000 hectares	

1/ Questionable feasibility of dam construction
2/ Based on 15,000 m^3/ha.
3/ Water supplies erratic from year to year and usually below capacity of dams.

Groundwater Development

Groundwater is the most complex, and in turn, the least well identified and described type of water resource in Syria. This applies especially to its annual replenishment and use. The Ministry of Public Works's test well program, and the Water Basins Administration's five-year study (Soviet contract), hopefully are and will be useful in improving the supply description. But the full extent of present use still remains unknown although some estimates have been made. Information is badly needed as a basis for water resource planning.

More adequate licensing and monitoring would be useful since only a portion of the wells are licensed, and there seems to be little continuing use-monitoring or compliance even with the specified use provisions of the licenses. Some authorities have estimated that overdrafts are occurring in several groundwater Basins. But new licenses continue to be issued in relatively large numbers in all Basins. And many other wells are drilled without licenses.

With improved information, a much needed integration of surface and ground water supplies and uses could be at least partially achieved.

Improved Water Use Efficiency

Except for the Euphrates project and one or two smaller projects, improved water use efficiency may be the major opportunity to enlarge the effective water supply in Syria.

A concerted effort is needed to describe and locate the present status of use efficiency and the opportunities to improve efficiency through management of use, land leveling, irrigation systems, sprinkler or drip irrigation, and optimum combinations of water and other production inputs. While obvious cases are identified, such as leaky canals and

unlevel land, very little is known about actual efficiency of use, especially on farms. Apparently a wide-scale need exists for the rehabilitation and renovation of irrigation distribution systems. Once programs are formulated, a critical need then is adequate financing for program agencies and individual farmers.

A number of measures and investments involved in improved water use efficiency follow.

Barada and Awaj Systems

The Barada and Awaj nets generally are viewed as obsolete. A serious pollution problem also exists. The General Administration of Major Projects is studying these river systems with a view to proposing projects for renovation and reorganizationof the systems. Obviously this area poses an extremely complex system of water rights and uses.

The Water Basins Directorate has proposed a "rivers flow control" program on the Barada and Awaj rivers. This program would involve four reservoirs -- two offstream -- and some redistribution of water use seasonally and geographically. Details of this proposal are not yet available.

Yarmouk Basin

Various proposals have been made for rehabilitation and reorganization of the irrigation system in the Yarmouk-Meskine-Dar'a areas. The Ministry of Public Works had planned for the construction of four dams in the area, and FAO included them in one of its projects. Three of the dams are about 25 percent completed, while the fourth has not yet been started.

Sprinkler Irrigation

Major Projects Administration currently has a contract study of sprinkler irrigation on 9,000 ha in the Sinn area. A Bulgarian study in the Upper Khabour proposed the use of sprinklers there based on a conclusion of 25 percent less water requirements and 10-20 percent increase in yields. Sprinklers may be a potential in the Ghab Valley in portions not excessively windy. Clearly the use of sprinklers poses investment and physical equipment and maintenance problems.

Renovation of Canals

While a major need exists for canal renovation, apparently few such activities are being carried out. But, as examples, it is estimated that 35 percent of the water diverted to canals in the Ghab Valley is lost before it reaches the farms. The Homs - Hama canal loses 54 percent of the water diverted, so that of 12-14000m^3/Ha diverted, only 6-7000m^3/ha reaches the farms. Consumation of any part of this program will require a decision and allocation of funds by the central government.

Qattineh Reservoir

The Water Basins Administration has also studied the possiblity of reducing seepage and evaporation losses on the Qattineh reservoir. A major element would be construction of a dike to reduce the area of the reservoir; a possible side affect would be an area that could be used for crop production. Apparently reports on this study are still forthcoming.

Supporting Programs

Improvements in water use efficiency also require expanded programs in research, information, and education as well as a pricing system and other institutional adjustments that will serve as incentives to efficiency measures.

Research and Education

A major need exists for an enlarged program in research and education relative to irrigated agriculture. Economic, agronomic, and engineering research all are needed, as well as an associated program to extend knowledge and research results to farmers and irrigation managers and administrators.

Research and analysis are needed on the economics of mechanization for small irrigated farms, irrigation water management, conservation practices, land leveling, kinds of irrigation, field layouts, input-output relations or irrigation water production functions, alternative crops and cropping patterns, the value of water to supplement rainfed crops, water requirements, and efficiency of water use.

Associated with this research is a need for an improved inventory and statistics regarding the location and quantity of irrigated land, especially in private development areas where there are no major projects.

RPU Program

A substantial need also exists for an adequate resource base classification system that is suitable for analysis of irrigated agriculture in Syria. The Resource Planning Unit is an approach to this problem, and a continuing program should be established toward its improvement, refinement and utilization.

Irrigation water supplies and uses need to be incorporated into the system. However, information is not yet available for delineating relevant water supply areas withing the RPU context. These needs include water supplies, water use efficiencies, input-output relations, costs of production, etc. that can be identified and described on a small area basis. In addition, the analytic capability to use the RPU system for this purpose also needs to be developed.

Water Resource Agencies

Numerous observers have concluded that substantial improvement is feasible and needed in the efficiency with which water resources use and development are programmed and managed. Various reorganizational recommendations have been made, including combination of all agencies into a single Water Resources Agency. The fact that changes have not occurred does not mean that they are not needed, although it could mean that the path is not clearly evident. But it appears that there are duplicating services and staff, that there is fragmentation of some programs among several agencies, that there is a lack of coordination and communication among agencies, and that there is a lack of information about what others are doing even within the same agency. It might also be added that there appear to be no economists or other social scientists in any of the water resource agencies.

Probably a first major need is for a professional analysis of the water establishment to be made by an inter-disciplinary water resource team.

Pricing Policies

Study and analysis is needed on the impacts that present policies and programs of water charges, and prices of outputs and inputs, have on the efficiency of water use and on the production of crops on irrigated land. For example, a flat charge per hectare means that farmers have no incentive to economize on the use of water. The opportunity may be substantial for improving water use efficiency through a system of charges based on water supply and use. A system could likely be devised which would be consistent with prevailing customs as well as with economic behaviour. Farmers need to be educated to efficient water use, but they still need some incentive as

as a basis for response. This question also is particularly relevant to repayment policies and programs with respect to irrigation investments such as the Euphrates Project.

Nonagricultural Water Uses

Domestic and industrial uses and increased demands for water should have priority for the water where competitive uses arise. A substantial need will exist in future years to meet the requirements of larger populations in the cities. And many smaller communities and villages have critical needs for adequate water supplies.

Pollution of streams and other problems of inadequate sewage disposal are serious problems throughout Syria. Priority attention should also be given to alleviating these problems by completing the projects underway or soon to be initiated.

The Ministry of Industry anticipates that industry construction in the current Five-Year Plan will be essentially completed by the end of the period. However, because of manpower and other shortages and problems, these industries plants will likely be operating only at 50 percent capacity. The views now are that industry in the next five-year period should minimize new construction and emphasize achievement of full capacity production in the existing plant.

International Waters

Compacts and agreements regarding use and development of international streams and supplies of water are always complex and difficult to achieve. But in their absence, uncertainties and constraints prevail and planning and developments are never entirely satisfactory. The Euphrates River is the major case in point for Syria. But several other streams and rivers have their origin in countries outside Syria. Probably it can only be noted here that there is a need for continuing efforts to achieve the necessary international agreements.

E. Conclusions and Recommendations

1. Hydrologists advise that the completion of the water development programs reviewed in the preceding section will essentially harness all of the surface water flows and spring flows above the reservoirs, except possibly the Euphrates River. Depending on the present redevelopment project under study, some spring flow waters would still go to the sea from the Orontes River.

2. Except for the Euphrates project and one or two smaller projects, improved water use efficiency may be the major opportunity to enlarge the effective water supply in Syria. Measures and investments involved here would relate to renovation of canals, rehabilitation and reorganization of irrigation networks, reduction of evaporation, improved water management, and introduction of technologies, such as sprinkler irrigation.

3. Groundwater resources are not well identified or described, especially with regard to annual replenishment and use. With improved information, a much needed integration of surface and ground water supplies and uses could be achieved.

4. Public irrigation development programs have been largely oriented toward construction of large-scale irrigation networks. However, these networks do not include a large portion of the total land area classified as irrigated. A careful review and analysis may be useful as to whether public funds are being too heavily allocated to large projects with associated inadequate attention being given to other needs and opportunities.

5. An essential step required for successful development of irrigated agriculture in the Euphrates project seems to be the rapid and complete pre-development of farm land, farm irrigation systems and drainage. The pre-development program should also be accompanied by a rigorous education program for settlers and managers.

6. To achieve agricultural production goals set for the Euphrates project, attention must be paid to the impact of mechanization as compared to the use of large amounts of hand labor. Goals will also be affected by indications that the area of land suitable for irrigated agricultural production may not exceed 50 percent of the area originally planned for use in the project.

7. A major need exists for an enlarged program in research and education relative to irrigated agriculture. Economic, agronomic, and engineering research are needed along with and associated programs to extend research results to farmers and irrigation managers and administrators. Improved statistics are needed, and data on irrigation water supplies and use need to be incorporated into the Resource Planning Unit (RPU) system.

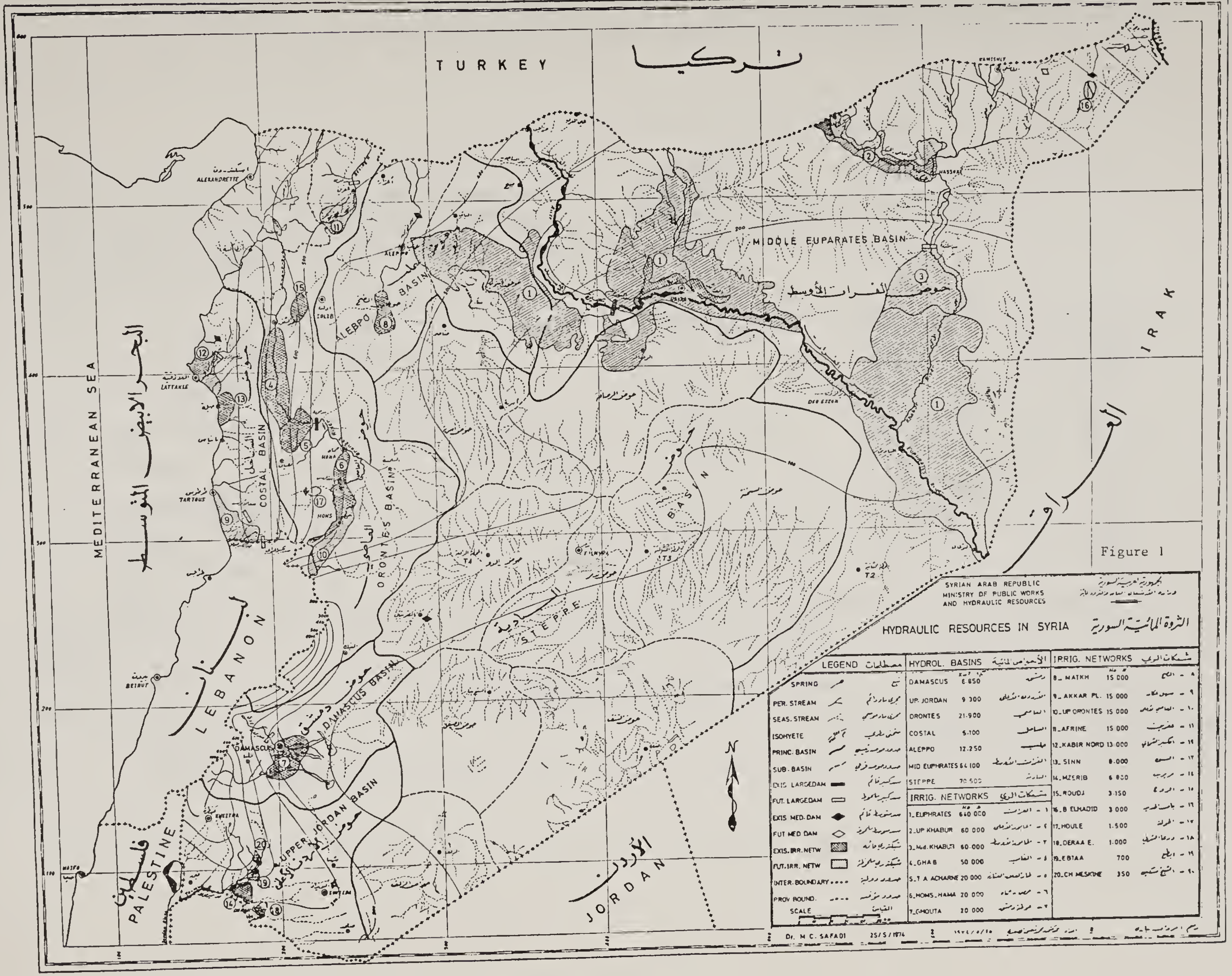
8. Attention is also needed with regard to feasibility studies to ensure that economic, social and environmental aspects of proposed water development projects are adequately considered.

9. In view of apparent problems in coordination and communication among the various water resource agencies, their overall organizational structure may benefit from a professional analysis by an interdisciplinary water resources team.

10. Analysis is needed on the impact that present water pricing policies and programs have on the efficiency of water use and on the production of crops on irrigated land.

11. Attention should be given to plans for meeting future water and sewerage system requirements of the expanding population.

12. There is a need for continuing efforts to achieve the necessary compacts and agreements on the use and development of international rivers and supplies of water.


TURKEY
IRAK
JORDAN
LEBANON
PALESTINE
MEDITERRANEAN SEA
MIDDLE EUPARATES BASIN
ALEPPO BASIN
ORONTES BASIN
COSTAL BASIN
DAMASCUS BASIN
UPPER JORDAN BASIN
STEPPE
BASIN
ALEXANDRETTE
LATTAKIE
TARTOUS
BEIRUT
HAIFA
DAMASCUS
HOMS
HAMA
ALEPPO
IDLEB
KAMISHLY
HASSAKE
DEIR EZZOR
PALMYRA
T2
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SYRIAN ARAB REPUBLIC
MINISTRY OF PUBLIC WORKS
AND HYDRAULIC RESOURCES
HYDRAULIC RESOURCES IN SYRIA
الثروة المائية السورية
LEGEND
SPRING
PER. STREAM
SEAS. STREAM
ISOHYETE
PRINC. BASIN
SUB. BASIN
EXIS. LARGEDAM
FUT. LARGEDAM
EXIS MED. DAM
FUT MED DAM
EXIS. IRR. NETW
FUT. IRR. NETW
INTER. BOUNDARY
PROV ROUND.
SCALE
HYDROL. BASINS
DAMASCUS 6 850
UP. JORDAN 9 300
ORONTES 21 900
COSTAL 5 100
ALEPPO 12 250
MID EUPHRATES 54 100
STEPPE 70 500
IRRIG. NETWORKS
1. EUPHRATES 640 000
2. UP KHABUR 60 000
3. Mid. KHABUR 60 000
4. GHAB 50 000
5. T A ACHARNE 20 000
6. HOMS. HAMA 20 000
7. GHOUTA 20 000
IRRIG. NETWORKS
8. MATKH 15 000
9. AKKAR PL. 15 000
10. UP ORONTES 15 000
11. AFRINE 15 000
12. KABIR NORD 13 000
13. SINN 8 000
14. MZERIB 6 800
15. ROUDJ 3 150
16. B ELHADID 3 000
17. HOULE 1 500
18. DERAA E. 1 000
19. EBTAA 700
20. CH MESKINE 350
Dr. M C. SAFADI 25/5/1974
Figure 1

Table 1. Area of agricultural land, by land classes, in the irrigation projects of the Euphrates Basin, SAR 1/

Project	Area (000 ha.) in land classes						
	1	2	3	4	5	6	Total
West Meskaneh	5.8	21.8	9.5	1.5	6.1		44.7
Balikh	30.9		28.7	16.8	-	54.7	131.1
Middle Euphrates	4.8	13.7	5.1	3.1	2.5	0.4	29.6
Rasafeh	15.5	4.2	3.8	8.9	-	29.6	62.0
Lower Euphrates	-	44.4		36.4	47.1		127.9
Totals	188.2			66.7	140.4		395.3
Percent	47.6			16.9	35.5		100.0

Source: GADEB, Al-Rakka (Based on translation from Arabic.)

1/ Not included above: West Meskaneh - 82,000 ha. (Soviet Classification)
Lower Khabour - 70,000 ha.
Mayadine - 40,000 ha.

Table 2. Land Classification criteria, Euphrates Project, SAR

	Land suitable for agriculture by grades				
Soil Characteristics	1st grade	2nd grade	3rd grade	4th grade	6th grade
Depth of soil to appearance of rock bases of aggregated gypsum	minimum limit 60 cm	minimum limit 60 cm	minimum limit 60 cm	30-60 cm	Depth less than 30 cm
Texture of soil	Loam to lightly clay	Loam to clay	Heavy clay	Loam to lightly clay	Light consistency aggregate and rocky
Base Chemical	Less than 9 Less than 5%	Less that 9 Less than 5-10%	Less than 9 10-15%	Less than 9 0-10%	Less than 9 More than 15%
Dissolved salts	0-4 millimhos	4-8 millimhos	8-10 millimhos	0-8 millimhos	more than 16 millimhos
Percentage of gypsum	Less than 25%	Less than 25%	Less than 25%	Less than 25%	More than 25%
Slope of land	0-2%	0-2%	2-4%	4-6% if the depth of soil is more than 60 cm.	More than 4% in the case of lands with depth less than 60 cm.

Source: GADEB, Al-Rakka/Alexander Gibb Co. - Balikh Basin, Euphrates, 3/79

Table 3. Average flow of rivers SAR, 1970-1976

m^3/Sec.

Rivers	1970	1971	1972	1973	1974	1975	1976
Euphrates	835.0	835.0	835.0	476.0	406.0	428.0	1100.0
Al-Khabour	48.0	50.0	43.0	35.0	-	18.0	56.4
Jaghjagh	3.0	5.0	4.0	2.0	-	1.5	-
Al-Balikh	6.0	6.0	6.0	-	3.7	-	-
Sajour	3.0	4.0	3.0	1.5	0.4	3.9	4.8
Orontes	NA	NA	50.0	25.0	-	16.9	49.7
Afrin	8.0	8.0	4.0	3.0	0.7	5.3	9.3
Queiq	5.0	1.5	5.0	5.0	0.0	-	0.4
Al-Kabir Al-Shamali	3.1	8.0	8.0	5.0	-	-	8.3
Sinn	12.0	12.0	12.0	8.0	-	-	12.0
Barada	11.0	11.0	10.0	2.4	3.0	4.2	8.7
A'waj	2.5	2.5	2.0	1.0	2.5	3.4	2.4
Al-Yarmouk	7.0	7.0	7.0	7.0	-	-	-
Al-Kabir Al-Janubi	3.0	4.5	3.0	1.5	-	-	13.0
Banyas	1.7	1.7	1.7	1.7	-	-	-
Sybarani	0.5	1.0	0.6	0.3	1.0	1.3	1.6
TOTAL			994.3	574.4			1266.6

Statistical Abstract

Table 4. Flow rates of rivers, selected years, SAR, 1967-1977

m^3/sec

Rivers	Flow Rate 1977			Flow Rate 1976		
	Min	Max	Average	Min	Max	Average
Euphrates	529.0	2885.0	1042.0	295.0	3685.0	1100.0
Al-Khabour & Tribs.	18.0	200.0	43.0	28.6	224.1	56.4
Jaghjagh	-	-	-	-	-	-
Al-Balikh	-	-	-	-	-	-
Sajour	0.8	60.8	4.2	0.6	64.8	4.8
Orontes & Tribs.	18.5	252.0	51.1	22.0	408.0	49.7
Afrin & Tribs.	0.6	92.0	8.0	1.1	145.0	9.3
Queiq	0.8	8.2	1.7	0.0	4.8	0.4
Al- Kabir Al-Shamali	0.5	14.3	4.9	0.4	29.3	8.3
Sinn	1.0	22.8	12.4	1.2	71.5	12.0
Barada	2.7	23.9	8.8	1.2	25.8	8.7
A'waj	0.4	12.7	2.5	0.2	10.3	2.4
Al-Yarmouk	-	-	-	-	-	-
Al-Kabir Al-Janubi	103	164	11.3	0.1	166.0	13.0
Banyas	1.0	3.2	1.4	-	-	-
Sybarani	0.3	5.5	1.2	0.1	15.6	1.6

Table 4 (Cont'd) Page 2 of 2

Rivers	Flow Rate 1975			Flow Rate 1973			Flow Rate 1967		
	Min	Max	Average	Min	Max	Average	Min	Max	Average
Euphrates	175.0	1600.0	428.0	145.0	2250.0	476.0	140.0	8500	830.0
Al-Khabour & Tribs.	2.0	290.0	18.0	20.0	63.0	35.0	21.0	500	48.0
Jaghjagh	0.1	7.6	1.5	0.1	30.0	2.0	0.0	100	6.0
Al-Balikh	-	-	-	-	-	-	0.5	12	6.0
Sajour	0.0	12.8	3.9	0.0	25.0	1.5	0.0	100	4.0
Orontes & Tribs.	2.7	59.6	16.9	2.0	50.0	25.0	NOT AVAILABLE		
Afrin & Tribs.	1.4	17.5	5.3	0.5	60.0	3.0	1.5	300	8.0
Queiq	-	-	-	0.0	60.0	5.0	0.0	70	2.0
Al-Kabir Al-Shamali	-	-	-	0.3	80.0	5.0	0.8	200	4.5
Sinn	-	-	-	6.0	11.0	8.0	6.5	22	11.0
Barada	2.1	8.0	4.2	1.5	5.0	2.4	3.0	75	10.0
A'waj	0.4	12.0	3.4	0.3	4.0	1.0	0.7	25	2.5
Al Yarmouk	-	-	-	7.0	100.0	7.0	7.0	100	7.5
Al-Kabir Al-Janubi	-	-	-	0.2	15.5	1.5	0.5	80	4.5
Banyas	-	-	-	0.5	5.0	1.7	0.5	5	1.7
Sybarani	0.1	3.8	1.3	0.1	3.0	0.3	0.7	7	0.5

Statistical Abstract

Table 5. Length of Syrian rivers, total and within Syria

River	Total length Km	Within Syria Km
Euphrates	2330	602
Al-Khabour	405	405
Jaghjagh	124	100
Al-Balikh	110	110
Sajour	108	48
Orontes	571	325
Afrin	149	85
Queiq	126	110
Al-Kabir Al-Shamali	80	56
Sinn	6	6
Barada	71	71
A'waj	66	66
Al-Yarmouk	57	47
Al-Kabir Al-Janubi	50	50
Banyas	1	1
Sybarani	15	15

Table 6. Main lakes in Syria

Name	Location	Area km^2	Notes
Al-Assad	Near Al-Thawra	625	Euphrates River
Al-Rastan	Near Hama	250	
Jabbul	Near Aleppo	150	Salt - dead sea 1/
Qattineh	Near Homs	61	Irrigation reservoir
Jeirud	Near Damascus	10	Salt - dead sea 1/
Autayba	Near Damascus	9	Salt 1/
Khatunieh	Near Al-Hasakeh	2	Salt 1/
Muzeirib	Near Dar'a	1	Fresh Water

Statistical Abstract

1/ These lakes are dead drainage basins that fluctuate with rainfall and may be dry part of the time each season.

Table 7. General location of selected gauging stations, SAR

River or Catchment Area	Station No.	Station Name	Location
Barada	1	Tekieh	Near headwaters
	2	El-Hama	Below Figeh Springs
A'waj	3	Oumal-Charatit	Below juncture of A'waj and Derany
Orontes	4	Kouseeir	Above Qattineh Reservoir
	5	Obiasy	Just above Hama
	6	Cheizar	Below Mouhardeh
	7	Jiel Chauchour	Below Jisrech Chegheur
Coastal	8	Al Kabir North	Upstream from Lattakia area
	9	Kiel Janoubi	Above Akkar Plain Area
	9A	Sinn	Largely water from Ain Sinn
Afrin	10	Midanky	Upstream toward headwaters
	11	Bassouta	Downstream below Afrin
Sajour	12	Dadat	Near Junction with Euphrates R.
Khabour	13	Rasel Ain-Convelant	Near Headwaters below spring
	14	Teltamer	Near Tell Tamer
	15	Hassakeh	Below juncture Al-Khabour and Jaghjagh
Yarmouk 1/	-	None	
Queiq 1/	-	None	Since 1968/69 in Min. of PW Office

1/ See reported Volumes in tables 8 and 9. Ministry of Public Works

Table 8. Average stream flows at selected gauging stations, SAR

River or Catchment Area	Station Map No.	m^3/sec 1/	$m^3/year$ 000	Percent of total in July and August
Barada	1	3.52	111,007	14.1
	2	7.87	248,188	10.5
A'waj	3	4.98	157,049	6.3
Orontes	4	17.0	536,112	17.9
	5	18.1	570,802	16.8
	6	7.47	235,574	22.6
	7	32.0	1,009,152	8.6
Coastal	8	3.67	115,737	3.3
	9	5.76	181,647	3.5
	9 A	11.00	3/	
Afrin	10	5.16	162,726	4.6
	11	4.62	145,696	6.6
Sajour	12	2.80	88.301	3.3
Khabour	13	43.4	1,368,662	15.2
	14	51.8	1,633,565	12.8
	15	45.4	1,431,734	13.4
Yarmouk	-	7.0 2/	220,752	-
Queiq	-	2.8 2/	88,301	-
Sinn	-	12.0 2/	378,432	-
Banyas	-	1.7 2/	53,611	-
Sybarani	-	0.9 2/	28,382	-

Ministry of Public Works

1/ Average of several recent years, depending on data availability

2/ Statistical Abstract reports. 3/ Primarily Ain Sinn - volume included with springs

Table 9. Stream flows by months at selected gauging stations, SAR 1976

M^3/sec

River and Station	O	N	D	J	F	M	A	M	J	J	A	S
Barada												
1. Tekieh	2.56	2.58	3.39	4.14	5.56	6.59	6.29	4.91	4.12	3.67	3.38	3.24
2. El Hama	2.48	2.37	3.94	5.16	7.23	13.6	23.0	20.8	11.6	6.32	4.60	3.90
Awaj												
3. Oumal-Chara-tit	0.36	0.55	1.93	2.80	4.41	5.81	5.32	2.58	1.64	1.09	0.95	0.63
Orontes												
4. Kouseeir	20.8	21.0	21.3	22.0	22.3	19.7	18.6	18.8	19.5	18.6	17.8	16.6
5. Obiasy	4.53	3.05	2.03	1.62	1.96	2.04	1.89	2.39	3.77	5.76	5.60	4.06
6. Cheizar	4.00	2.80	2.44	0.90	1.10	1.24	1.24	1.66	3.40	14.00	13.40	6.48
7. J. .l Chau-chour	18.0	18.8	23.7	57.5	66.6	55.4	37.9	37.7	18.9	9.6	8.0	9.6
Coastal												
8. El Kabir North	0.0	1.38	11.00	12.16	9.07	8.92	5.18	5.69	1.49	0.14	0.07	0.02
9. K.El Janoubi	2.3	3.0	5.8	9.4	15.6	10.7	9.9	4.3	2.4	2.2	0.7	0.9
Afrin												
10. Midanky	1.13	1.47	2.60	18.40	24.20	14.80	21.00	16.80	6.35	3.36	2.12	1.85
11. Bassouta	1.57	2.39	2.95	20.10	26.00	17.10	23.60	17.60	6.96	3.43	2.74	2.50
Sajour												
12. Dadat	1.74	3.08	3.66	5.50	8.45	8.55	10.40	8.62	4.01	1.41	0.97	1.25
Al-Khabour												
13. Rasel Ain	39.8	40.2	44.7	70.7	66.2	61.7	73.0	49.1	40.7	39.9	39.5	39.4
14. Teltamer	50.0	50.0	55.7	97.2	103.5	90.2	113.8	NA	34.1	36.4	35.2	39.1
15. Hasakeh Convelant	39.7	40.5	44.4	86.1	93.7	81.2	108.9	50.2	36.1	31.4	30.9	34.0

Ministry of Public Works

Table 10. Storage capacity of dams completed and under construction by Hydrologic Basins, SAR

Hydrologic Basins		Constructed		Under Construction	
No.	Name	Number	000 m^3	Number	000 m^3
1	Jezireh				
	Euphrates	1	12,000,000	0	
	Other	6	38,185	2	21200
2	Kwaik	3	6,908	0	
3	Jabboul	1	3,500	0	
4	Al-Daw	4	6,323	0	
5	Palmyra	0		0	
6	Khanaser	2	2,400	0	
7	Al-Zalf	2	19,700	1	1200
8	Wadil-Miyah	2	3,750	0	
9	Al-Rasafa	2	1,720	0	
0	Al-Tanf	1	10	0	
11	Al-Sabi-Byar	1	1,750	1	270
12	Horan	12	25,105	8	32768
13	Damascus	3	4,368	2	2600
14	Orontes				
	Medium 1/	3	475,000	0	
	Other	15	26,951	3	18930
15	Coastal	7	22,352	3	21435
T O T A L S		65	12,638,022	20	98403

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1/ Excludes Tel Daou in The Orontes Basin.

Table 11. Number of reservoirs completed, by years, SAR

Year	Number	Notes	Year	Number	Notes
1977	3		1966	3	
1976	0		1965	2	
1975	1		1964	1	
1974	3		1963	0	
1973	2		1962	1	Mehardeh
1972	3	Euphrates	1961	0	
1971	2		1960	1	Rastan
1970	3		Before 1960	1	Kattineh
1969	10				
1968	15		No date	5	
1967	9				
			TOTAL	65	

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Table 12. Dams planned and expected to be exectued 1979-1981, by purpose, SAR

Hydrologic Basins		Number	Capacity	Purpose 1/			
No.	Name		000 m^3	I	FC	D	I-D
1	Jezireh	6	40,100	3	1	1	1
2	Kwaik	1	2/				
3	Jabboul	0					
4	Al-Daw	0					
5	Palmyra	0					
6	Khanaser	1	5,000			1	
7	Al-Zalf	1	22,000			1	
8	Wadil-Miyah	2	9,500			2	
9	Al-Rasafa	0					
10	Al-Tanf	1	1,000			1	
11	Al-Sabi-Byer	0					
12	Horan	1	1,000			1	
13	Damascus	2	3,500	1			1
14	Orontes	1	2/				
15	Coastal	7	28,090	3		3	1
	TOTALS	23	109,190	7	1	10	3

Ministry of Public Works

1/ I = Irrigation; FC = Flood Control; D = Domestic and Livestock
2/ Failed hydrologically

Table 13. Summary of storage capacity of reservoirs and percent filled, SAR, 1978

Hydrologic Region	All reservoirs No.	All reservoirs Capacity 000 m3	Reservoirs with Supply Data Total Storage 000 m^3	No.	Water Supply 000 m^3	Percent
1	1	12,000,000	12,000,000	1	7,560,000	63
	6	38,185	38,185	6	31,290	82
2	3	6,908	908	2	0	0
3	1	3,500	3,500	1	0	0
4	4	6,323	6,323	4	C	0
5	0		0			
6	2	2,400	2,400	2	230	10
7	2	19,700	19,700	2	0	0
8	2	3,750	515	1	70	22
9	2	1,720	1,720	2	434	25
10	1	10	10	1	10	100
11	1	1,750	1,750	1	0	0
12	12	25,105	25,105	12	6,900	27
13	3	4,368	4,368	3	1,718	39
14	3	475,000	475,000	3	475,000	100
	15	26,951	11,951	14	7,362	62
15	7	22,352	29,284	6	29,284	100
T O T A LS	65	12,638,022	12,620,719	61	8,112,298	64
Totals w/out large & medium			145,719	57	77,298	53

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Table 14. Reservoirs Storage capacity and percent filled, SAR, 1972-77

Dam	Location	Storage Capacity	Percent of Capacity Filled					
			1977	1976	1975	1974	1973	1972
Large:		000 m^3						
Euphrates	Al-Tahka	11,600,000	63	63	-	-	-	-
Medium:								
Al-Rastan	Al-Rastan	250,000	80	100	100	100	80	-
Mouhardeh	Mouhardeh	50,000	100	100	100	100	80	-
Taldo	Taldo (Homs)	15,500	100	100	100	100	100	-
Surface:								
Richeh	Damascus	1,750	-	-	-	-	30	30
Al-Dumair	Duma	2,150	9	10	-	31	50	50
Al-Kalamoun	Al-Naher	1,630	-	-	-	20	-	-
Al-Klalfeh	Al-Ktal	502	-	-	-	18	-	-
Wadi-Al karm	Al Kabadour	1,700	52	55	40	73	100	100
Al-Ain	Salkhad	580	62	100	86	86	50	50
Dar'a	Dar'a	1,500	7	-	60	40	50	50
Um Jloud	Aleppo	3,500	3	7	10	20	-	-
Al-Shahba	"	12,000	40	70	56	30	100	100
Maskanah	Homs	960	-	-	-	-	100	100
Al-Mohsinieh	"	600	38	38	80	90	100	100
Al-Talil	"	1,000	74	98	80	75	-	-
Khirbet Al-Haman	"	1,250	85	100	87	85	100	100
Al-Kariatain	"	5,000	-	-	35	30	-	-
Al-Shandakleb	"	1,250	-	-	100	82	-	100

Table 14 (continued)

Dam	Location	Storage Capacity	Percent of Capacity Filled					
			1977	1976	1975	1974	1973	1972
		000 m^3						
Al-Marba	Homs	3,200	-	-	-	55	-	-
Al-Wadi Al-Kabir	"	515	-	-	-	50	50	-
Jhab Shakra	"	975	-	-	-	78	50	50
Sraiheen	Hama	1,000	9	6	-	20	-	50
Al-Kafat	"	1,500	-	-	31	10	50	50
Al-Lattamneh	"	650	-	-	-	-	-	-
Al-Ilbawi	"	1,400	12	14	30	15	-	50
Abou Faiad	"	1,100	-	-	-	-	100	-
Wadi Al-Azeeb	"	930	38	42	-	15	100	-
Beit Al-Kaser	Lattakia	737	-	68	68	70	-	100
Burmana	"	1,365	74	99	95	100	75	100
Al-Wa'ar	Deir-ez-Zor	3,345	-	-	-	75	50	-
Karima	Al Hambra	1,900	2	-	95	50	75	75
Abou Al-kahf	Al-Rakka	620	-	-	90	80	50	50
TOTAL		11,983,609	-					

Statistical Abstract   Note: (-) Probably means not available

Table 15. Storage capacity of completed reservoirs by purpose and hydrologic basins, SAR

Basin	Irrigation		Flood Cont.		Domestic		Irrigation Flood Cont.		Irrigation domestic	
	No.	m^3 000	No.	m3 000	No.	m3 000	No.	m3 000	No.	m3 000
1 Euphrates							1	12000000		
Other	4	33340			1	3345			1	1500
2			2	6230	1	678				
3			1	3500						
4					3	5323			1	1000
5	0		0		0		0		0	
6					1	1000			1	1400
7					1	200			1	19500
8					2	3750				
9					2	1720				
10					1	10				
11					1	1750				
12	3	19000			7	5853			2	252
13			1	2150	1	1718			1	500
Medium							3	475000		
14 Orontes	9	8370	1	1000	2	651	1	15000	2	1930
15 Coastal	5	3852			1	3000	1	15500		
Total	21	64562	5	12880	24	28998	6	12505500	9	26082
Average		3074		2576		1208		2,084,250		2898

(12,638,022)

Ministry of Public Works

Table 16. Storage capacity of reservoirs under construction by purpose and hydrologic basin, SAR

Basin	Irrigation		Flood Control		Domestic		Irrigation Flood Cont.		Irrigation domestic		Flood and Domestic	
	No.	m^3 000	No.	m^3 000	No.	m^3 000	No.	m^3 000	No.	m^3 000	No.	m^3 000
1	2	21200										
2												
3												
4												
5												
6												
7					1	1200						
8												
9												
10												
11					1	270						
12	5	30228							2	2215	1	325
13			1	400					1	2200		
14	1	2600							2	16330		
15									3	21435		
Total	8	54028	1	400	2	1470	0		8	42180	1	325
Average		6754		400		735				5272		325
				(98403)								

Ministry of Public Works

Table 17. Number and flows of springs by hydrologic basin, five-year average, SAR

Hydrologic Basin	Springs Number	Size range 1/sec	Total Number 3/	Flows 1/sec	Average size 1/sec
Yarmouk	45	1-1399	40	4609	115
A'waj	28	6-1207	26	4752	183
Barada	64	1-8000	42	12552	299
Orontes	69	14-6424	46	25252	549
Coastal	17	253-10485	8	18683	2335
Afrin	18	2-1440	18	2722	151
Aleppo	4	2- 32	4	91	23
Khabour	0 2/		0		
T O T A L S	235		184	68661	373

Source: Ministry of Public Works

1/ Aleppo and Afrin data available only 2-3 years.

2/ One large spring is a major source of water for Al-Khabour River.

3/ Data not available for some springs, mostly either small or dry.

Table 18. Major springs by hydrologic basin, five-year average, SAR

Basin and Name	1/sec	Basin and Name	1/sec
Yarmouk			
Mzaireeb	1399	El Houwayez	676
Zeizoun	760	El Charia	4366
		El Toueini	1779
A 'WAJ		Ere Nord	631
Kafa Arichen	609	Ere Cenzral	771
El Merej	593	Ere Suo	782
Mounboj	1207		
Tamassiat	829	Coastal	
Tabibieh	700	Sourite	1865
		Markieh	2437
Barada		Cheikh Hasan	500
Barada	3000	El Khalifeh	520
Figeh	8000	El Nassirieh	850
Orontes		El Sinn	10485
Al Tannour	1594	Banyas	1773
Chizer	6424	Afrine	
El-Bared	2234	Saboun Saoui	1440
Naouret Jorine	647		
El-Fawar	677	Aleppo	-
		Euphrates	
		Ras Al Ein	40000

Table 19. Number and flow of springs by subareas of the Orontes Basin, five -year average, SAR

Subarea	Springs Number	Size range 1/sec	Total flows Number	Total flows 1/sec	Average size 1/sec
Above Katineh Dam	4	275-1594	3	2255	917
Between Hama and Mouhardeh Dam	7	14- 216	6	453	76
Mouhardeh to Ascharne	1	6424	1	6424	6424
Trib. at head of Ascharne canals	6	33-2234	2	2267	1134
Along west Ghab	19	35- 647	17	3889	229
A long east Ghab	10	48-4366	10	7588	759
Jezreeh Chaghour to Idleb	4	52- 782	4	2236	559
North Portion - No drainage evident	5	13- 72	3	140	47
S.W. of JezreehChaghour	1	-	0	-	
Other	2	-	0	-	
T O T A L	59		46	25252	549

Ministry of Public Works

Table 20. Annual flows of several major springs, SAR ,1970-1977

1/sec

Spring	1977	1976	1975	1974	1973	1972	1971	1970
Figeh	7340	8937	5880	6530	4400	6740	7470	6720
Mzeireeb	1089	1612	1318	1407	667	1500	1700	1700
El Tammour	800	870	914	1300	1300	1500	1500	1500
El Fawar	790	1040	915	275	275	300	554	500
El Bared	1930	2100	1960	804	804	1300	1283	1283
Banyas	1480	1480	1465	1417	1200	1700	1700	1700

Statistical Abstract

Table 21. Recent measurements of major springs in Damascus Basin, SAR

1/sec

Spring	1976	1977		1979	1979
	December	January	April	November	January
Sarada	199 1/s	96 1/s	68 1/s	57 1/s	78 1/s
Barada	4.3 m^3/s	8.02 m^3/s	22.3 m^3/s	4.14 m^3/s	4.256 m^3/s
Ras El Yafour	207 1/s	174 1/s	330 1/s	427 1/s	324 1/s
Figeh	140 1/s	1.3 m^3/s	4.9 m^3/s	238 1/s	123 1/s
Ain Khadra	77 1/s	211 m^3/s	160 1/s	144 1/s	160 1/s
Mnine	206 1/s	270 1/s	0.56 m^3/s	281 1/s	153 1/s
Fasraya	279 1/s	-	0.312 m^3/s	116 1/s	179 1/s
Ras el Ain Katana	28 1/s	269 1/s	239 1/s	28 1/s	31 1/s
El Bardeh	142 1/s	166 1/s	243 1/s	52 1/s	137 1/s
El Malha	140 1/s	151 1/s	134 1/s	81 1/s	122 1/s
El Mereg	0799 m^3/s	805 1/s	1.590 m^3/s	-	-
Mounboj	0.299 m^3/s	0.828 m^3/s	0.700 m^3/s	Dry	36 1/s
Tamassiat	792 1/s	0.950 m^3/s	0.935 m^3/s	712 1/s	787 1/s
Tabibieh	0.689 m^3/s	0.730 m^3/s	1.010 m^3/s	791 1/s	895 1/s

Ministry of Public Works

Table 22. Sources of water for irrigated land, by Mohafazat, SAR, 1976

(Hectares)

Muhafazat	Nonpump irrigation			Pump irrigation			
	Rivers water wheels	Rivers springs	Total	Wells	Rivers	Total	Total
Damascus-City	-	906	906	672	20	692	1598
Damascus	110	23565	23675	45573	392	45965	69640
Dar'a	-	2428	2428	215	11858	12073	14501
Sweida	-	-	-	-	-	-	-
Quneitra	-	530	530	470	-	470	1000
Homs	-	23250	23250	14933	994	15927	39177
Hama	206	9155	9361	20974	2222	23196	32557
Ghab	-	33409	33409	8393	-	8393	41802
Lattakia	-	1259	1259	4297	11398	15695	16954
Tartous	-	4439	4439	10498	1199	11697	16136
Idleb	17	4458	4475	6792	1992	8784	13259
Aleppo	-	4487	4487	54972	7770	62742	67229
Hasakeh	-	500	500	35809	42200	78009	78509
Al-Rakka	15	6362	6377	21704	34836	56540	62917
Deir-ez-Zor	-	-	-	1231	90201	91432	91432
T O T A L	348	114748	115096	226533	205082	431615	546711

Annual Agricultural Statistical Abstract 1976

Table 23. Pumps used in cultivation, SAR, 1967-76.

Year	Total	10" or more	Less than 10"
1967	26846	2014	24832
1968	27897	2230	25667
1969	28176	2209	25967
1970	29042	2376	26666
1971	29437	2424	27013
1972	29954	2161	27793
1973	32192	1705	30487
1974	37591	1604	35987
1975	40416	1940	38476
1976	40500	2086	38414

Agricultural Statistics 1976

Table 24. Pumps used in cultivation by Mohafazat, SAR, 1976

Mohafazat	Number
Damascus City	70
Damascus	8,554
Dar'a	104
Al-Sweida	-
Quneitra	63
Homs	4,875
Hama	3,795
Ghab	759
Lattakia	1,760
Tartous	1,822
Idleb	1,212
Aleppo	9,967
Al-Hasakeh	2,502
Al-Rakka	2,281
Deir-ez-Zor	2,736
TOTAL	40,500

Agricultural Statistics

Table 25. Pumping licenses issued, number of engines, size of engines, and pumps sold, 1961-68, SAR

Year	Pumping License	Number of Engines	Horse Power	Pumps sold
1961	3204	5486	75117	1119
1962	913	1049	15577	822
1963	1272	1322	20449	570
1964	1743	1938	37460	700
1965	2317	2643	55472	668
1966	3154	3422	54425	434
1967	2467	2561	51203	481
1968	1721	1736	27623	481

Statistical Abstract 1968

Table 26. Pumping licenses issued first time and licenses renewed, SAR, 1970-77

Year	Licenses issued		Total
	First time	Renewed	
	(Number)		
1977	1650	2259	3909
1976	1442	2329	3771
1975	1551	1838	3389
1974	1863	2940	4803
1973	1445	1628	3073
1972	1858	2265	4123
1971	-	-	4494
1970	-	-	2820
T O T A L	-	-	30,382

Statistical Abstract

Table 27. Number of pumping licenses issued for the first time (FT) and renewed (R), by Mohafazat, SAR, 1972-77.

Mohafazat	1977		1976		1975		1974		1973		1972	
	FT	R	FT	R	FT	R	FT	R	FT	R	FT	R
Damascus	45	42	36	85	25	142	47	119	47	319	49	395
Aleppo	513	464	671	412	222	265	581	517	-	458	841	901
Homs	72	180	48	163	105	166	68	206	118	398	42	65
Hama	194	39	55	391	70	118	72	874	-	-	38	199
Lattakia	49	-	74	-	36	-	145	9	159	-	159	-
Deir-ez-Zor	149	531	79	251	253	240	95	281	436	207	266	255
Idleb	71	162	84	144	68	148	96	149	-	178	41	317
Al-Hasakeh	121	384	103	380	302	454	242	542	5	59	-	100
Al-Rakka	320	409	228	470	415	225	473	214	570	-	331	28
Al-Sweida	-	-	-	-	-	-	-	-	-	-	-	-
Dar'a	-	1	-	-	-	2	-	-	-	1	-	5
Tartous	116	47	64	33	55	78	44	29	110	8	91	30
Quneitra	-	-	-	-	-	-	-	-	-	-	-	-
Totals	1650	2259	1442	2329	1551	1838	1863	2940	1445	1628	1858	2265

Table 28. Selected information about a sample of test wells, by basin, SAR

Basin	Number of Wells	Years of drilling	Depth range meters	Yield range 1/ m^3/hr	Quality PPM
Yarmouk	27	1935-78	38-310	2.4-100.0	244-2356
Damascus	42	1957-76	30-500	0.8-158.0	180-800
Orontes	46	1953-77	34-476	3.0-108	300-1334
Coastal	16	1957-68	20-519	5.5- 49.0	2/ 712- 772
Aleppo	42	1957-68	66-412	2.5-55.8	358-1129
Northeast	72	1957-64	30-870	2.4-64.0	220-7350
Steppe	71	1954-75	71-570	1.0-40.0	355-18522
Total	316				

Ministry of Public Works 1/ Not including "dry" wells 2/ Only 2 wells

Table 29. Selected data for Water Basin Administration test wells, by basin, SAR

Basin	Wells No.	Depth range meters	Discharge range 1/sec
Damascus	42	25-425	0.35-11.4
Orontes	52	80-555	0.1-26.8
Coast	15	128-355	1.0-20.2
Aleppo	42		1/

1/ Most wells not yet tested

Table 30. Water quality at Barada River Station 1/, SAR

M O N T H	No. of station	Date of having the sample	Time	Temperature °C	PH	Dissolved oxygen mg/lit	Saturation percentage	Conductivity	Distance M D
November 1978	1	11/25	10:30	14	8.2	9	0.94	240	17
	5	11/25	12:15	12	8.2	10.5	1.039	400	4.85
	19	11/30	12:00	12	7.39	4	0.396	560	12.0
	29	12/3	9:15	12	7.1	0.5	0.05	700	8.90
December 1978	1	12/23	10:30	12	7.45	9	0.89	240	13.40
	5	12/23	12:30	12	8	12.5	1.24	400	4.90
	19	12/28	9:40	13	7.62	4.5	0.45	520	19.70
	29	12/27	11:30	12	7.72	6	0.59	610	10
January 1979	1	1/27	9:50	12.5	7.56	13.5	1.35	-	2
	5	1/27	12:00	12	8.20	12.8	1.26	-	4.20
	19	1/30	12:30	13	7.23	3.1	0.31	470	8
	29	1/29	11:10	13	7.43	4.4	0.44	-	8
February 1979	1	2/20	10:30	14	7.52	7.5	0.87	240	13
	5	2/20	12:20	14	8.39	11.75	1.22	250	5
	19	2/25	10:20	15	7.63	2.9	0.3	520	12
	29	2/24	11:55	15	7.69	4.2	0.44	900	14.00

Table 30. (Cont.)

MONTH	No. of station	Mean time T	Velocity $v = \frac{D}{T}$	Height of bridge over the water	Area of the section of the water	Discharge	Chlorine cl	Amoniam NH^3 mg/lit	Suspended material mg/lit	Dissolved biological oxygen $B.O.D.^5$
November 1978	1	98.5	0.172	-	-	-	17.5	0.5	5	0
	5	6	0.80	-	-	-	12	0	30	8
	19	38	0.315	-	-	-	25.5	15	220	76
	29	35	0.254	-	-	-	37.5	5	110	21
December 1978	1	30	0.44	0.96	28.11	12.37	17	0.7	5	14
	5	7	0.7	5.20	7.8	5.46	12	0.3	30	8
	19	42	0.47	1.00	1.65	0.78	26	10.5	110	90
	29	15	0.67	-	-	-	37.5	3.5	100	20
January 1979	1	9	0.22	110	26	5.72	2.5	0	-	0
	5	3.5	0.28	485	11.65	3.25	8.5	0.1	-	4
	19	23	0.35	180	1.26	0.44	13.5	8.75	160	128
	29	23	0.34	80	0.52	0.18	25	19	25	60
February 1979	1	29	0.45	0.95	25.2	11.34	0	0.05	0	12
	5	3	1.66	5.10	8.9	14.77	9	0.1	10	10
	19	25	0.48	1.20	2.75	1.32	24.0	18	110	398
	29	33	0.42	-	-	-	25	6	65	10

1/ Station Locations: No. 1 - headwaters of Barada River; No. 5 -upstream from first industrial developments above Damascus; No. 19 - downstream on a central canal; No. 29 - near the termination of a southern canal.

Table 31. Percent of total major crops under irrigation, SAR 1976

Crop	Percent of Area	Percent of Production
Winter Crops		
Wheat	12	25
Mexican wheat	46	55
Barley	1	2
Lentil	4	7
Chick peas	1	1
Rambling vetch	1	2
Sern	7	12
Bitter Vetch	1	2
Cabbage	100	100
Cauliflower	100	100
Lettuce	84	86
All Winter	11	-
Summer Crops		
Maize	87	95
Millet	8	15
Cotton	95	99
Sesame	29	50
Tobacco	2	5
Sugar beets	82	85
Peanuts	100	100
Tomato	70	91
Water melon	9	18
Potato	86	91
Snake cucumbers	58	73
All Summer	61	-
Fruits		
Olives	2	6
Grapes	6	13
Figs	4	9
Apricots	85	93
Nuts	80	33
Apples	50	73
Pomegranates	76	82
Pistachio	1	2
Citrus	100	100
All fruit	12	-

Table 32. Crop intensity ratios (CIR) on irrigated land by Mohafazat. SAR 1976

Mohafazat	Summer Crops		Winter Crops		All Crops 1/	
	Area	Percent	Area	Percent	Area	Percent
Damascus-city	834	148	1283	228	562	376
Damascus	24092	54	26979	61	44471	115
Dara'a	9210	69	4001	30	13385	99
Al-Sweida	-		-		-	
Quneitra	300	30	824	82	1000	112
Homs	29997	88	14917	43	34164	131
Hama	12771	42	24485	81	30173	123
Ghab	33816	81	7912	19	41520	100
Lattakia	16032	121	278	2	13236	123
Tartous	17045	129	4316	32	13240	161
Idleb	9328	76	5947	49	12196	125
Aleppo	40149	63	35727	56	63547	119
Al-Hasakeh	41127	53	40887	53	77430	106
Al-Rakka	37957	61	29645	47	62552	108
Deir-ez-Zor	53605	60	47132	53	89241	113
T O T A L	326263	66	244333	49	496717	115

Agricultural Statistical Abstract 1976

1/ Except fruit. This procedure may overestimate the intensity ratio because of double cropping of fruit areas. The reports do not indicate where these double crops are reported, if at all.

Table 33. Production and consumption of drinking water, by Mohafazat, SAR 1976

Mohafazat	Production 000 m^3	Consumption: Priced 000m^3	Free 000m^3	Lost 000m^3
Damascus	95995	53513	23651	18831
Aleppo	45021	32027	1036	11958
Homs	23725	12000	2008	9718
Hama	9125	5767	1095	2263
Lattakia	12775	5475	3650	3650
Al-Rakka	4752	1644	1865	1243
Al-Sweida	409	365	7	37
Al-Hasakeh	2513	1284	250	979
Idleb	2773	2143	456	174
Deir-ez-Zor	5000	2800	1320	880
Dar'a	1500	800	400	300
Tartous	8000	3817	2433	1750
Al-Kamishly	1800	1475	75	250
Queneitra	-	-	-	-
T O T A L	213,388	123,110	38,246	52,032

Statistical Abstract Table 8/5

Table 34. Estimated Water Requirements for Major Crops, Selected Projects, SAR

1. Lower Euphrates Basin (Reference 12)
(Wheat, vetch, barley, corn, legumes, sesame, cotton, sorghum, beets.)

(m^3/ha)	Plant Requirements	Leaching	Total
January	110	-	-
February			
March	580	1100	1800
April	620	1180	1800
May	1030	545	1575
June	1830	870	2700
July	2905	470	3375
August	2170	1200	3375
September	1310	490	1800
October	350	495	900
Noverber	55	-	-
December	-	-	-
TOTAL	10695	6360	17325

2. Balikh Irrigation Project (Reference 16) 1/

(mm)

Month	Cotton	Wheat	Maize	Sesame	Alfalfa	Vegetables
January	-	-	-	-	-	-
February	-	6	-	-	-	-
March	-	61	-	-	61	12
April	51	98	-	-	98	80
May	116	141	-	-	167	167
June	187	-	-	93	249	218
July	258	-	172	242	276	242
August	233	-	204	204	262	204
September	62	-	166	146	166	125
October	-	-	92	79	92	79
November	-	11	5	-	24	-
December	-	-	-	-	-	-
TOTAL	907	317	639	764	1395	1127

1/ Maximum water requirements are in July. The proposed cropping pattern would have net water requirements of 2009 m^3/ha in July or 0.75 l/sec/ha. Overall water efficiency assumed is 55 percent; 10 percent conveyance loss; field efficiency of 60 percent. Average annual gross water requirement per hectare 17,400 m^3/net ha. Design duty 1.375 l/sec/ha, which is adequate.

Table 43. (Cont.)

3. Akkar Plain (Reference 29)

This analysis developed consumption use requirements by land classed by aggregating individual crop estimates by months. As examples of crop requirements (in mm): Small vegetables - 332; Maiza - 519; Tomatoes - 334; Dry beans - 347; Wheat - 558; Citrus - 1050; and Sorghum - 698.

By land classes, which were also estimated by months (in mm): Land class I - 620; Land class II - 813; and Land class III - 797.

Total system and farm efficiency was 60 percent with a diversion requirement of 1032 mm per hectare or 10,320 m^3/ha.

4. Houran Development Project (Reference 11)

Several illustrative estimates in this study are as follows in mm (none in October through December):

	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	TOTAL
Beans	34.0	75.0	109.0	109.0	-	-	-	-	327
Cucumbers	-	-	-	-	94	121	126	-	341
Tomatoes	-	-	-	48	85	152	164	135	925

5. Ghab Valley (Reference 10)

Estimated irrigation water requirements using the worldwide known Blaney-Griddle formula:

Month	At field 1/ (mm/ha)	At tertiary outlet (mm/ha)	At main canal (mm/ha)	For 37,000 ha mm^3
May	127	159	176	65.2
June	130	163	181	67.0
July	127	159	176	65.2
August	130	163	181	67.0
September	53	66	73	27.2
Year	567	710	787	291.6

1/ 55 percent efficiency

APPENDIX A

CANAL NETWORKS IN SYRIA [1/]

A.1 Governmental Irrigation Networks

Project	Mohafazat	Type of Irrigation	Source of water	Hydromodel lit/ha/sec.	Irrigated area (Ha)	Date of exploitation
1. Yarmouk						
Upper Mzireeb	Dar'a	pumping in Ashary station	springs	0.40	1946	1966
2. Yarmouk						
Middle Mzireeb	Dar'a	pumping in Tell Shhab station	springs	0.40	2802	1966
3. Yarmouk						
Lower Mzireeb	Dar'a	Gravity	Yarmouk	0.50	2204	1947
4. Yarmouk						
Al-Ajamy	Dar'a	Gravity	Ajamy spring	0.50	215	1959
5. Abta	Dar'a	Gravity	Abta dam	0.50	500	1974
6. Sheikh Maskin	Dar'a	Gravity	Um Dananir's spring	0.40	353	1959
7. Dam of Dar'a East	Dar'a	pumping	Dar'a East	0.50	280	not well exploited
8. Homs-Hama	Homs	gravity	Dam of Kattina lake	0.20	1245	1939
9. Homs-Hama	Hama	gravity	Dam of Kattina lake	0.20	7410	1951
10. Homs-Hama	Hama	pumping	Orontes	0.20	375	1951
11. Tar Ala Asharneh	Hama	gravity	Mhardeh dam	0.33	18934	1968

APPENDIX A

A.1 (Continued)

Project	Mohafazat	Type of Irrigation	Source of water	Hydromodel lit/ha/sec.	Irrigated area (Ha)	Date of exploitation
12. Sin El.11						
Soukass	Lattakia	gravity	Sin spring	0.50	450	1950
13. Sin El.26						
Jableh	Lattakia	pumping	Sin spring	0.50	2750	1953
14. Sin El.50	Lattakia	pumping	Sin spring	0.50	3700	1965
15. Sin El.80	Lattakia	pumping	Sin spring	0.50	2100	1967
16. Rouj	Idleb	gravity	Oraï Thalath springs	0.50	3100	1963
17. Tall Magass						
Hasakeh	Hasakeh	gravity	Khabour	0.50	4542	1959
18. Bab Al Hadid	Hasakeh	gravity	Babl Hadid dam	0.50	2248	1979
19. Jawadieh	Hasakeh	gravity	Jawadieh dam	0.50	750	1978
20. Madakh	Aleppo	gravity	Kweik	Variable	14860	not well exploited
21. Kom Al Wesieh and Ein Nourieh	Quneitra	pumping	group of springs	0.50	260	1971
22. Fawar spring	Quneitra	pumping	Fawar spring	0.50	170	1971
23. Ein Al Beida	Quneitra	pumping	Ein Al Beida spring	0.50	40	1971
TOTAL					71,234	

Ministry of Public Works

APPENDIX A

A.1 (Continued)

1/ Project numbers are identified by irrigation networks shown in Figure 1 as follows:

Network	Project	Network	Project
14	1,2,3,4,5	15	16
20	6	2	17
18	7	16	18,19
6	8,9,10	8	20
5	11	Quneitra	21,22,23
13	12,13,14,15		

The magnitude 0.5 l/sec is used frequently in design circles, etc. Apparently it is basically a design concept for canals and is oriented to a "mean" capacity; that is, it is not a maximum capacity of canal design.

Several notes about canals in the Asharneh - Ghab areas are of interest. The maximum capacity of canls in Asharneh is reported at 14 m^3/sec. A similar magnitude for Ghab canals is 26 m^3/sec.

In 1978, the following releases were in effect for canal below Qattineh Reservoir which serves the Homs - Hama areas, in m^3/sec:

March 4	2.0	Dec. 31	2.0
May 4	10.15	Jan. 31	0.5
July 31	10.8	Feb. 15	0.4
Nov. 1	4.0		

A.2 Barada Canals

Barada River Canals 1/	Capacity of Canal m^3/sec	Average Flows 2/ m^3/sec
1	9	3.5
2	4	1.5
3	6	2.0
4	8	4.0
5	3	1.5
6	2	2.0
TOTALS	32	14.0

Ministry of Public Works

1/ These canal diversions are all upatream from the city of Damascus. The numbers are consecutive canals and diversions moving downstream.

2/ These magnitudes are probably useful in terms of the relative allocations among canals; they should not be used as absolute flows of the river, however.

APPENDIX A

A.3 Ghouta Canals - Douma area

	Village	Canal	Total length M.L.	Covered part wells & tunnels M.L.	Discharge lit/sec.
1.	Dmeir	Makbout spring	3000	50	26
2.	"	Mattaroun spring	2000	1700	31
3.	"	Dreiseh "	2700	2000	5
4.	Douma	Fasreya "	9000	50	215
5.	"	Public canal of Douma	5000	4000	Dry
6.	"	Mazra'a canal	5000	3000	"
7.	"	Mazra'a T labdeh canal	2000	600	"
8.	Shifonieh	Canal of Kabou	3000	1800	"
9.	Hafir Tahta	" " Hafir	500	500	1.5
10.	Rihan	Barcin spring	3000	2000	Dry
11.	"	Rihan spring	3000	1500	"
12.	Otaya	Rass 1 Shab	1000	200	"
13.	"	Otaya spring	2000	100	"
14.	Hosh Salhieh	Zanbaka spring	2000	500	"
15.	" "	Oyoun Beit Nayem spring	1000	50	2.5
16.	Ska	Ska spring	3000		Dry
17.	Nhasieh	Nhasieh spring	4000	1500	"
18.	Dlbieh	Dlbieh spring	800	60	"
19.	Karahta	Guzlanieh spring	3000		"

APPENDIX A

A.3 Ghouta Canals - Eastern area

	Village	Canal	Total length M.L	Covered part wells & tunnels - M.L.	Discharge lit/sec.
1.	Shab'a	Hazoun spring	7000		Dry
2.	"	Sukkar spring	6000		2.50
3.	Hosh Dweir	Feid spring	2000		16.00
4.	Deir l Asafir	Mfadada spring	1000		16.00
5.	Zubdin	Bzineh spring	1500		12.00
6.	"	Haroush spring	7000		35.00
7.	"	Ein Amrieh spring	5000		10.00
8.	Mhamadieh	Oyoun l Kalaya	6000		30.00
9.	Hammora	Ras l Ein	5000		Dry

APPENDIX A

A.3 Ghouta Canals - Western area

	Village	Canal	Total length M.L.	Covered part wells & tunnels M.L.	Discharge lit/sec.
1.	Bbibbila	Bahdalieh canal	2500	1000	10.00
2.	Ylda	Set Zeinab canal	5000		20.00
3.	Kadam	Ylda Sultani canal	3000	1500	20.00
4.	Mokhayam Yarmouk	Ylda Asronieh canal	1500	1000	31.00
5.	Basatin Shaghour	Um Ranes canal	2000	7000	10.00
6.	" "	Adrwanieh canal	3700	1000	20.00
7.	Sahba	Hosh Shhir spring	4000	50	Dry
8.	Najha	Deir Hajar spring	5000		"
9.	Sbeineh	Boueida spring	2000		"
10.	Boueida	Sahba canal	2000		"
11.	Ylda Hosh Roumaneh	Hjeira canal	3000	1500	"
12.	Hajar Aswad	Hmeira canal	3000	1000	"
13.	Sahnaya	Sbeineh L Koubra canal	4000	2000	5.00
14.	Ard Daraya	Sbeineh L Sougra canal	3000	700	
15.	Ard Sahnaya	Shawaka canal	2000		Dry
16.	Daraya	Zawyeh spring	1500	500	"
17.	"	Ein Nab'at	2000	500	"
18.	"	Ein Mas Oudeh	2500		"
19.	"	Ein Amya	3000	600	"
20.	"	Wadi canal	2000	600	"

APPENDIX A

A.3 Ghouta Canals - Western area (Cont.)

	Village	Canal	Total length M.L.	Covered part wells & tunnels M.L.	Discharge lit/sec.
21.	Daraya	Marjat canal	1600		Dry
22.	"	Shabourieh canal	2000	500	"
23.	Hameh	Syafi spring	100	surface current	30.00
24.	"	Dayamseh spring	50	" "	12.50
25.	"	Arrad spring	200	" "	14.50
26.	Jdaydet Al Wadi	Fater spring	300	" "	9.00
27.	" " "	Ein Hares spring	250	" "	11.00
28.	" " "	Hummeh	250	" "	8.50
29.	" "	Al Hawakir	400	" "	8.00

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Syria: Agricultural Sector Assessment

Volume 2: Natural Resources Annex

CHAPTER III

RANGE AND LIVESTOCK RESOURCES

By

Calvin C. Boykin, Jr. and Faress C. Khoury

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PREFACE

During this three-month study we received considerable assistance from officials of the Directorates, Ministry of Agriculture and Agrarian Reform, particularly the Directorates of Steppe, Range and Sheep, and Animal Health, both at the Mohafaza and central levels.

Chiefs of the Range and Sheep Stations spent time with us touring the stations and discussing their work. Their assistance is appreciated greatly.

Particular contributions were made by Mr. Al-Masri, Director, Steppe, Range and Sheep, who counseled with us on several occasions concerning the present situation and problems of the sheep industry in the Steppe.

CHAPTER III

RANGE AND LIVESTOCK RESOURCES

A. Introduction

Objectives of the Assessment

The overall objective of the Agricultural Sector Assessment and that of the assessment of the range-sheep sub-sector, is to be of assistance to the Syrian Arab Republic Government in the development of (a) the fifth Five-Year Plan (1981-1985) by establishing an improved information and data base upon which to guide its formulations, and (b) an improved indigenous capacity and data base to carry out effective long-run economic analysis and planning for the agricultural sector.

Terms of Reference

For the range-sheep subsector assessment the result would be a report focusing on the national sheep industry including production and marketing of meat, wool and milk. The current use of seasonal range, crop aftermath and drylot sheep feeding would be described and analyzed. The several existing reports would be reviewed and integrated. The current productivity of the sheep industry output relative to flock size and feed use will be appraised. The report would (a) describe the existing industry with as much quantification as possible; (b) evaluate the limiting factors, including overstocking, low reproductive rate, lack of integration of crop and livestock enterprise; (c) provide suggestions for raising output; (d) give special attention to possible overgrazing, plowing and cutting of shrubs, resulting in deterioration of the range and reduced animal production, and to the effect on the environment, such as causing the range areas to be more susceptible to erosion.

The major task of the range-sheep subsector specialist was to (a) review existing data and reports; (b) visit the sheep raising, fattening and marketing areas; (c) write an integrated report.

The range-sheep subsector specialist would work with the Head of Animal Production Research Department, The Agricultural Scientific Research Directorate (MAAR), as counterpart. Together they would travel to Homs, Hama, Aleppo and Kamishly. The Department of Range, Sheep and Steppe and Animal Husbandry (MAAR) officials would be major contacts along with those with the Meat Bureau (MS & HT).

B. Special Physical Factors

Syria's physical setting in the Middle East has already been outlined in detail in Chapter 1 of the Annex. Two additional factors of importance to range and livestock problems should be considered here - plant zones and bioclimatic regimes.

Plant Zones

Eight major plant zones have been identified in Syria (Pabot, 1957), as shown in Figure 1. They are: Mediterranean, Cedar, Jordan, Syrian, Jebel Druze, Syrian Continental and Steppic. Most of these zones have been divided into subzones, the native plants being listed by zone generally and by subzone more in detail. Included in these plant lists are trees, shrubs, grasses, grasslike plants and forbs. However, little indication is given about the grazing values of the individual species nor how they react under various grazing pressures - that is, which ones would decrease in population, increase or invade the land under different degrees of grazing.

These questions become academic in the cropping areas where the native plant populations have long since been destroyed by plowing, except in areas where fallowing is practiced and the native plants tend to regenerate themselves. Only these fallow lands and on isolated parcels of land among the cultivated areas that are too steep, rocky or otherwise inaccessable for grazing would native plants of any consequence be found. For localities in the Steppic Plant Zone, the occurrence and abundance of the native plants listed are highly dependent upon whether or not the range has been overgrazed or plowed.

Bioclimatic Regimes

Emberger's formula, used in the preparation of the climatic regimes map for Syria, results in the division of Syria into five regions (as shown in Figure 2.) The formula relates average annual precipitation to both the temperature mean and range and is pertinent to the discussion of livestock production systems in Syria, particularly in regard to the Steppe.

Humid Region (I)

Most of this region consists of mountains lying within the Lattakia, Tartous and Quneitra Mohafazat, and includes those areas with at least 800 mm of average annual precipitation. At the highest elevations precipitation averages 1200 - 1400 mm annually. Red Mediterranean soils are dominant, the region including the Mediterranean Cedar and Alpine Plant Zones. The region can support non-irrigated crops successfully, although much of the land is in forests and is either too steep or too rocky for farming.

While the forests are stateowned, nonirrigated crops are grown on privately owned lands in the foothills and narrow valleys. Tree crops are common, including fruits and nuts. Cereals and vegetables are grown among the fruit and nut trees and in separate small fields. Crop residues furnish grazing for local livestock following harvest.

Native cattle graze along the roadsides, on small, isolated pastures, ranging occasionally into the foothills and edges of the forests. A few small flocks of Syrian mountain goats and Awassi sheep, sometimes together, graze similarly, although goats are not permitted to graze the stateowned forests. Although livestock graze on crop residues following harvest, native vegetation, including leaves and young growth of trees and shrubs, constitute the bulk of the diet.

Semi-Humid Region (II)

This region consists of coastal plains and foothills of the Lattakia and Tartous Mohafazat, the Golan Heights, Quneitra, and the higher mountainous area of Al-Sweida Mohafazat. Average annual precipitation is 300 to 800 mm. Included in the region are the Ghab and Rouge Plains, both of which are irrigated, and the western plains of Homs. Red Mediterranean soils occur along the coastal area of the region, phasing into the grumosol soils to the east, although cinnamonic soils occur in Al-Sweida Mohafaza area. This region includes parts of the East Syrian, Mediterranean, and Marsh Plant Zones (Fig.1).

Along the coastal plains citrus is grown primarily, while olives and tobacco are important crops in the foothills. Cherries, figs and apples are also grown. In the irrigated sections of the Ghab and Rouge Plains, cotton, maize, sugar beets and vegetables are grown in summer and cereals and vegetables in winter. Poplar trees for timber and pulpwood are grown in some localities.

Natural and planted forests occur on land that is stateowned and the land at higher elevations. Orchards and interplanted cereals, pulses and vegetables crops, as well as separately planted fields, are privately owned. The precipitation is sufficient in most of the region for successful dry farming, although springs furnish irrigation water to many farmers.

Many village-owned livestock graze in the foothills, around villages, and on cropland following the harvest of cereals, pulses and vegetables. Native cattle of the Julani, Okshi and Shami breeds are used for milk production. And farm work, particularly since many fields are small, hilly, and occur among orchards, making machine cultivation and harvest physically difficult and often uneconomic. These cattle when culled or the young bulls when fattened contribute to meat supplies. Small flocks of village-owned Syrian mountain goats and Awassi sheep graze also, in the pattern mentioned above, producing meat, milk, wool and hair, consumed or used locally. State lands which are forested may not be grazed by goats, but sheep and cattle can graze these areas. Neither these small village flocks nor the cattle herds move out of the region for grazing.

Semi-Dry Region (III)

This region is composed of plains and a few isolated mountainous formations lying within the Aleppo, Idleb, Hama, Homs, Damascus, Al-Hasakeh and Al-Sweida Mohafazat. Average annual precipitation, higher to the west and increasing with elevation, ranges 350 - 500 mm. Grumusol soils predominate in the region, blending to the east and south with cinnamonic and isolated segments of ground-water soils. This region includes primarily the East Syrian, small parts of the West Syrian and Steppic, and a part of the Syrian Continental Plant Zones in the northeast, (Fig.1).

Most of the land is privately owned, operated by holders and owners who live in villages, many of whom belong to cooperatives. The main crops are wheat, barley, cotton, summer vegetables, sorghum, maize and mixed fruit and nuts. Fallowing is practiced in the region, although legumes such as vetch, medic and lentils are increasingly planted on fallowed land in rotation with cereal crops. Wheat is more frequently planted in the higher rainfall areas; barley is grown principally where there is less rainfall. Small parcels of land are irrigated by pumps from underground water supplies and from springs, these lands being planted to cereals, cotton, sugarbeets and vegetables. State-owned lands, other than those in the northeast which is farmed, consist of interpersed hills and low mountains unsuitable for cropping; livestock periodically graze there under state permits.

Awassi sheep, Syrian mountain goats and some flocks of mixed sheep and goats graze together in the region. Male lambs are fattened near the larger cities or moved out to the Steppe for weight gain prior to marketing or being placed on feed. Milk and wool are important products in the sheep-raising enterprises: themilk is processed into cheese, yogurt, butter or ghee.

The Julani and Okshi, native cattle breeds, are located in the region, their primary purpose being milk production, although culls and young bulls may be fattened before slaughter. Some cattle are used for farm work on the smaller, steeper, rockier lands that are unsuitable for mechanized farming.

A major contribution of cropland agriculture in this region is the residues following harvest used for grazing by livestock, including locally owned cattle, sheep and goats. During drier periods in the Steppe, when pasture and water supplies are short, sheep are moved in from that region also.

Dry Region (IV)

Most of this region consists of plains and low hills, bisected by the Euphrates River. Included in this region are southern Al-Hasakeh, northern Deir-Ez-Zor, and parts of Al-Rakka, Aleppo, Idleb, Hama, Homs, Damascus and Dar'a Muhafazat (Fig.2). Annual precipitation averages 200 to 350 mm. Soils are the cinnamonic group primarily, with rather large areas of alluvial soils along the Euphrates, Al-Balikh and Al-Khabour rivers, although gypsiferous soils interrupt occasionally.

This region includes parts of the East Syrian, Steppic and Southern Syrian Continental Plant Zones, (Fig.1). Most of the plants mentioned may only be found only in isolated, noncultivated areas, although some of the native plants appear briefly during crop-fallow rotations.

Much of the dryland area is planted to cereal crops, primarily to wheat in the higher rainfall areas and barley farther east where rainfall is lower and less certain. Along the river cotton, sorghum, maize, vegetables, and cereal crops are grown under irrigation and there are also some orchards. Crop residues provide grazing through the summer and early autumn, the dryland cereal residues are grazed first, followed by irrigated crop residues.

In the far northern sections of this region and along the eastern edge, Okshi cattle are grazed, used for milk production and some work. Bull cattle and young bulls are fattened in feedlots locally and around the larger cities.

Sheep, primarily Awassi, is the dominant livestock enterprise in the region, producing milk, meat and wool. Male lambs are fattened in feedlots near the larger cities or moved to crop fields for fattening. A large proportion of the sheep that graze here, including the Jezireh of the region, come in from the Steppe to graze on crop residues.

Very Dry Region (V)

This region, the "true" Steppe, includes the east-central and southern parts of Syria, where average annual precipitation is only about 200 mm or less, the lowest being some 100 mm in the south-central part of the country, (Fig.2).

Inlcuded in this region are the southern part of Hasakeh, most of Deir-Ez-Zor and Al-Rakka, part of Homs, Hama, Damascus and Al-Sweida Mohafazat. The Khabour River joins the Euphrates River in this region, with alluvial soils bordering these rivers, gypsiferous and desert soils occur elsewhere.

The Steppic Plant Zone dominates in the region (Fig.1) the plants including shrubs, grasses, legumes, and grasslike plants. Although regarded to be land not suitable for cultivation, except under irrigation, a narrow band along the west side is planted periodically to barley wholly dependent upon rainfall and accumulation of runoff water in the lower places. If the rainfall is not sufficient to make grain, the barley is grazed and if the rainfall is exceptional a grain crop may be harvested.

Along the rivers, irrigated cotton, sorghum, maize and vegetables are grown in summer, while vegetables and cereal crops are grown in winter. In some localities there are fruit orchards. Residues following harvest provide grazing for sheep.

Sheep-raising is the primary livestock enterprises, although lambs may be grazed here during a growing-out period before slaughter or being fattened in feedlots near the larger cities outside the region. A major product is milk, which is processed into cheese, yogurt, butter or ghee. Some flocks are kept in the region by Bedouin who live there, while other flocks are moved there from the west.

A few camels are grazed in this region. They belong to Bedouin, who tend to have few if any sheep. The camels are kept for milk and meat and sometimes perform as beasts of burden during crop harvests in the region to the west.

C. Status of the Agricultural Sector

Value of Animal Production and Foreign Trade

Animal Production

The total value of animal and crop production in Syria amounted to S.L.6220.8 million in 1977; of this animal production accounted for S.L.1686.9 million, or about 27 percent. Livestock production amounted to 51 percent of the value of total animal production, milk and milk products 34 percent, wool 3 percent and animal hair 2 percent. Eggs, fisheries and miscellaneous other products not associated with cattle, sheep or goats composed the remainder. According to the values reported the increase in annual production, at first glance, appears significant. For instance, between 1971 and 1977 the value of animal production increased over 216 percent. However, at constant prices with 1963 as a base, the total value of animal production increased only about 40 percent (Central Bureau of Statistics, Statistical Abstract, 1978).

Imports and Exports

Despite this increase in the value of animal production, Syria imported more than S.L.950 million in Animal Products in 1977, including foreign trade and commercial exchange figures. Imports of dairy products and eggs headed the list of animal product imports at almost S.L.208 million, while meat and meat preparations totaled almost S.L.14 million and live animals almost S.L.11 million. These figures do not include temporary entry of animals for subsequent export. Exports of animal products and live animals, including re-exports, totaled S.L.243 million in foreign trade and 97 million in commercial exchange (Central Bureau of Statistics, Statistical Abstract, 1978). Syria has benefited from the import and export trade in meat and live animals. Yearling rams are imported from Turkey, Bulgaria and Romania for fattening; exports of meat and live animals move into Jordan, Lebanon and the Gulf States.

Livestock Population and Production

Livestock Population

The total number of sheep in Syria in 1977 has been estimated at 7.1 million head, goats one million, cattle 639 thousand and camels, for 1976, 7 thousand (Table 2). Between 1971 and 1977 sheep numbers increased 30 percent, goats 36 percent, cattle 26 percent, while camel numbers decreased 26 percent between 1971 and 1976 some estimates reveal that 70-75 percent of the sheep in Syria are controlled by Bedouin who graze them at one time or another on the Steppe.

Livestock Production

Total milk production from all kinds of milking animals combined rising gradually since 1971, reached 647 thousand tons in 1977 (Table 3). With the emphasis on imported dairy cattle the past few years, sheep's milk has declined from 42 percent of the total in 1971 to 37 percent in 1977.

Meat production in 1976 totaled 94 thousand tons with mutton and lamb accounting for over 50 percent of the total (Table 4). Poultry comprised one-fifth of the total and beef and veal almost 30 percent.

Animal Feed Crops and Estimated Production

In view of Syria's increasing livestock numbers, one needs to examine the sources, amounts and proportions of the feed supply available for animal use. The principal crops used in livestock production - those producing grain for direct feeding or limited to the grazing values of straws and residues - are listed in Table 5. Also included are the industrial crop contributions to livestock grazing, pastoral crops and range.

Average yields for each crop during 1971-1977 are applied to the amount of land planted to the crop in 1977. Given the total production for each crop, factors are used to determine the proportion of total production that is used for livestock. For instance, in the case of wheat, with a total production of 1,742 thousand tons, only about one percent is expected to be fed and that is broken grain. With barley, the principal feed grain crop, it is expected that 90 percent would be fed to livestock. Chaff and straw are figured at factors of ten percent and fifty percent of total grain production respectively. Pastoral crops are figured directly at 3.6 tons produced per hectare, fallow lands o.1 ton and range 0.2 ton. All production estimates are made on a dry-weight basis. These estimates, based largely on experience and informed judgement, are only approximate and should be used with some caution until improved estimates are made on the basis of additional observations.

Estimated Contribution of Feeds

Total digestible nutrients (TDN) values are assigned to the total production derived in Table 5 for each crop used in any manner in livestock production (Table 6). These crops are grouped into feed grains, straws, stubbles, residues, byproducts, pastureland, fallow land and rangeland. For each crop or other category a factor is applied which is an estimate of the proportion of each of these crops or categories used by sheep. For instance, an estimated 90 percent of all wheat and barley stubbles is grazed by sheep, while only half of the barley grain production is used by sheep. While an estimated proportion of pastureland grazing (in the more humid areas) is about 50 percent by sheep and 50 percent by other livestock, the proportion of range grazing by sheep is figured at 100 percent. Results of these estimates indicate that 1,484.5 thousand tons of TDN are available for sheep production, including raising and fattening (Table 6). The largest proportion of TDN is expected from rangeland, 46.1 percent, next is stubbles at 21.8 percent, then feed grains at 14.8 percent.

Feed Availability Compared with Sheep Requirements

An estimated 2,609.8 thousand tons of TDN are required for sheep raising and sheep fattening in Syria (Table 7). Subdivided into these two categories, the raising activity requires 2,228.3 thousand tons, 85 percent of the total, while fattening requires an estimated 381.5 thousand tons, 15 percent of the total.

Comparing these total sheep requirements with the estimated amount of 1,484.5 thousand tons of feed available for sheep reveals a deficit of 1,125.3 thousand tons of TDN (Table 7). This estimate of feed production from crops, residues, pastures, rangelands and other sources represents a deficit of some 43 percent, assuming the current number of head in both sheep raising and fattening are to be maintained at adequate nutritional levels.

These estimates, based largely on experience and informed judgement, are only approximate and should be used with some caution until improved estimates are made on the basis of additional information. These observations conceivably would be more specific to disaggregated estimates of yields of crops and crop residues at the bioclimate zone levels and particular nutritional differences among the kinds of feed produced.

D. Situation in the Steppe

History and Use

The bulk of Syria's sheep flocks are kept by nomadic or semi-nomadic Bedouins still influenced by practices and customs of traditional pastoralism, the earliest type of agriculture in the area. Traditionally the Bedouins moved their camel herds and sheep flocks from place to place, searching for pasture and water. Their living needs were met from meat and milk and occasional village raids. In the past 20 years, sheep, the traditional herding animal of the common Bedouin tribes, have gradually replaced camels as the herding animals of the noble tribes (Chatty, 1978). Now the richer noble tribes herd sheep with the help of modern equipment, while the poorer common tribes herd camels.

Each tribe had traditional rights of range use which were recognized; difficulties associated with the exercise of or violations of these rights were settled within the tribe or among the tribes, although not always in a peaceful manner.

As human and sheep populations expanded in the steppe, some Bedouin found opportunities in cropping areas to engage in extensive agriculture such as dryland barley raising to increase income and better feed their sheep. In later years, as pasture supplies diminished in the Steppe, more and more nomads and migratory flocks moved to the farming areas to the west and north for a large part of the year.

Meanwhile, the traditional rights of use in the Steppe, claimed by most tribes on certain range sites which were recognized in Syria and supported by the previously applied Tribal Act, were stopped through abandonment of the related Traditional Laws or Ourf Law. Range deterioration has since been accelerated through the conception now maintained by most governments of the region, which consider the Steppe rangeland as State or Government-owned land. The tribes were neither compensated for the loss of these rights nor, until recently, provided with a systematic plan for sheep use of these rangelands and a destructive system of uncontrolled grazing has prevailed.

Except for the more recently initiated government programs to establish Range Development Cooperatives, thus encouraging demarkation of grazing areas, the Steppe has largely been rangeland open to all. The situation became, and still is over much of the Steppe, what can been referred to as the "tragedy of the commons" (Hardin, 1968). Writing in abstract terms, Hardin explains the tragedy in this manner:

> As a rational being each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, 'what is the utility <u>to me</u> of adding one more animal to my herd?' This utility has one negative and one positive component.
> 1. The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.
>
> 2. The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsmen is only a fraction of -1.
>
> Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to purchase is to add another animal to his herd. And another; and another ---- But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit--in a world that is limited.

Thus, use of the Syrian Steppe's rangelands appears to involve a multitude of problems, most of them recognized, although the establishment of a control system is difficult and will require a concentrated and continuing effort.

Description of the Steppe

Several methods may be used to delineate the Steppe; most of the discussions deal with the question of what is Steppe and what is land suitable for farming.

Stabilization Zones

According to the stabilization zone map, zone 5, with 200 mm average rainfall or less, encompasses what is referred to as the Steppe, (Fig.3). This includes 55 percent of the land area of Syria. Within this area about three-fourths of the total land is classed as grazing land or pasture. However, area 5 includes a large amount of marginal farming land.

Bioclimatic Zones

The bioclimatic zone map also may be used to identify the Steppe, designated as Region V, although no figures are available for indicating the proportions of total area by land use (Fig.2). One can say that bioclimatic Region V, classed as very dry, is the true Steppe. Even here a narrow band of land on the western side of the region has been plowed and is periodically planted to barley.

Rainfall Patterns in the Steppe

Although the precipitation in the Steppe falls during October - May, the amounts and distributions received during this period vary from year to year. Five main reporting stations in the Steppe were averaged for each year, 1970-1977 (See Table 8). Deviations were determined from the average for each year and the terms relating to these deviations were assigned in percentages as follows: Greater than 34, very good; 12 to 33 percent, good; -2 to +11 percent from average, considered average; -3 to -14 percent, dry; -48 percent and less, considered a very dry year. Thus, over a period of eight years, stations in the Steppe recorded three average years (1971,1975,1976), two very dry years (1970,1973) and one each of very good (1974), good (1972) and dry (1977). As the amounts and distributions of rainfall change from one rainy period to the other, within years and between years, so the amount of quality of vegetation to be grazed by sheep change.

This variability of rainfall patterns and amounts has severe repercussions on the some 70 percent of Syria's sheep that spend some time in the Steppe. The index of sheep numbers trends down from 1970 through 1973, despite the increase in the rainfall index during 1971 and 1972, (Fig.4). Then the sheep numbers index trends upward more sharply from 1973 on as rainfall increased in 1974. However, the sheep inventory index continued upware as near average rainfall occurred in 1975 and 1976, and a dry year in 1977. While the amount of

rainfall is often of less importance than the distribution and intensity with which it falls, meaning that total rainfall in itself is not the best indicator of pasture supply on the Steppe's ranges, there must still be other factors involved in the increase in sheep numbers. Of importance is the supplemental feeding during dry years to substitute for the reduction in pasture-grazing. Also, many sheep perhaps spent a larger time on crop residues to the west, particularly the irrigated areas. Of consideration also is the lack of accurate counts of national sheep numbers.

Plants of the Steppe

Two major plant zones have been identified (Pabot, 1957); the Steppic Plant Zone and the mountains of the Steppic Zone, (Fig 1). The first zone has been subdivided into nine subzones depending on location within the Steppic Plant Zone and according to special soil-water conditions. The second zone has been divided into three subzones and includes the mountains at different locations.

Many plant species have been listed by Pabot, which may be referred to in the general list for the Steppic Zone, (Table 9). A more complete listing by subzone may be seen in his report.

As described by Draz (1974), the more valuable grasses for grazing include Poa sinaisa, P. bulbosa, Stipa barbata, S. lagascae. Some of the more valuable subshrubs and legumes include Halosylon spp, Salsola vermiculata, S. Lancifolia, Astrogalus spp. and Onobrychis spp. Plants of less value for livestock grazing include Noea mucronata, Peganum harmala, Carex stenophylla, Hordeum murinum and Stipa capensis (Draz, 1974).

Grazing in the Steppe

Sheep are first in importance in the Steppe, where they are kept for production of meat, milk and wool. At present, sheep grazing on rangeland of the Steppe depends mainly on annual and perennial plants that provide pasture in a semiregular pattern of rotation. Herders move their sheep in accordance with the succession of plant growth (Khoury, 1966).

In February sheep begin grazing on annuals such as Hordeum murinum, Plantago ovata, P. cylnidrica, Astragalus palmirinsis, Lotus lannginostia and Carex stenoppylla, then, where present, perennial species such as Poa sinaicia, Stipa barbata, S. logascae, Medicago arabica and others. During late spring and summer, sheep continue grazing on these species and graze the subshrubs and shrubs as Artemisia herba alta, Achillon conferta, Lactuca damascous syriaca, Tucrium parviflorem, Salvia lanigera, S. syriaca, Salsola vermicul, Helianthenum sessififlorum, Prosopsis fancata, Ziziphora persica, Ephedra alata, and E. campylopoda. In late summer and autumn, sheep remaining in the Steppe graze dried Halosylon articulatum, and the seeds of Peganum harmala after the plant dries. Dried-out or cured foliage remaining after the end of the rains and the earlier grazing periods would also be grazed. Salsola spinsosa, Cornulaca setifier and Astragalus spinosus are grazed by camels but not so much be sheep.

Grazing Systems and Patterns of Sheep Movement

The yearly patterns of sheep movement in Syria vary from year to year, depending upon rainfall and pasture supply in the Steppe primarily. These patterns, designed by Khoury (1979) in Fig.5, portray sheep movements during December-February and May-June. Appended to these movements are the systems themselves. Three main types of grazing systems are generally used in the Steppe (Khoury, 1966):

(i) Constant grazing in the Steppe by nomads living in the Steppe;
(ii) Easterly and westerly movement; practiced by nomads who live in villages and towns near the Steppe;
(iii) Temporary system of eastern movement into the Steppe; practiced by semi-nomads living in villages and other village people who own large flocks.

The first system, constant grazing of the ranges, undertaken by some nomads living in the internal areas of the Steppe. This system depends on staying in the Steppe throughout the year and within certain boundaries, the nomads centering around water resources. This is practiced either because the nomads cannot provide the capital for the necessary means of transport or because they prefer to adhere to traditional tribal customs and conventions.

The easterly and westerly movement of sheep is an old system of grazing and is seasonal in nature. It is practiced by some of the nomads who live in the areas adjoining villages or close to larger towns and spend the winter with their sheep at Al-Hammad area (far southeast Steppe). In spring they will move their sheep west until they reach the borders of the villages and towns in search of grazing lands and water. When the short grass that grows in the valleys has been grazed or dries up at the end of the rainfall period and most of the watering sources have dried up, the nomads move their sheep into the farming areas of western Syria and Jezireh, where they graze on wheat and barley stubbles. They will also graze their sheep during this period on the natural grazing lands of Al-Jolan and the mountains of the Steppe mountains.

Easterly movement of sheep usually takes place in October, depending on the time and occurrence of the availability of grass there. The nomads arrive with their sheep at Al-Hammad, where they spend the winter. When February-March comes, they move on to the middle of the Steppe, which by then, depending on rainfall, will be grazing grass. In the better rainfall years, some nomads stay with their sheep in Al-Hammad all through the year. In this situation their sheep are in better condition than those that are moved to the west.

The third system of grazing is practiced by the semi-nomads who live in villages and some village people who own large flocks. This is the temporary system of eastern movement of sheep into the Steppe. In this case the shepherds leace their villages and families after having made an inspection tour to find the good grazing lands, then move their sheep in February. After spending February. After spending February - May, in the Steppe, they return the sheep to the cropland areas around the village for grazing on barley stubbles.

Barley Production in the Steppe

As mentioned previously, some of the semi-nomads and farmers who live in villages on the western margin of the Steppe periodically plow the land for planting barley. This is a marginal area for crop production (at least 200-250 mm of rainfall is the minimum requirements) and the chances of harvesting a grain crop are extremely low. Nevertheless, those who plant barley have the alternative of grazing the barley with sheep once it has been determined that a grain crop will not be formed or that the potential yield would be uneconomic to harvest. Land such as this, having been plowed in previous years, is devoid of the more palatable pasture plants. Thus, if sufficient rainfall is received to germinate the barley and get some leafage, more grazing can be obtained than would otherwise be possible. If a grain crop is harvested, there is still the opportunity to graze sheep on the straw and stubble remaining and on grain seeds that fall to the ground during harvest.

While increased mechanization has brought on an increase in plowing by people who live in these marginal areas, part of the reason for plowing is related to the opportunity for the operator to become the owner of this land once it is plowed. This practice has been against the plans of the Government for agricultural development and protection of natural resources. In addition, the practice has been looked upon with disfavor among many of the Bedouin themselves, particularly those who follow the more traditional systems of grazing and who consider farming as secondary or prefer not to farm at all.

Fuel Gatherings from Rangelands

Range vegetation on the Steppe provides much of the fuel for domestic use, despite efforts by the Government to assist the Bedouin in the purchase of kerosene and other type of stoves and to discourage the practice of uprooting. Woody plants are preferred, but grasses and even annual plants are gathered, with little attention to grazing values lost. Palatable subshrubs, shrubs or trees such as *Salsola vermiculata*, *S. lancifolia*, *Haloxylon articulatum*, *H. salicornicum* and *Quercus spp*. are rated highly as firewood (Draz, 1974). *Artemisia herba alba* and *Atriplex spp*. are also highly rated as fuel. These and other such shrubs are used for both cooking and heating. The introduction of motorized transport has extended fuel gathering to great distances from the villages and camps.

Water Resources

Use of the Steppe by man and his sheep is dependent upon water. Water for sheep is a necessary adjunct to utilization of rangeland and a valuable tool in proper grazing distribution and management. The nature, quality and supply of water for both domestic and animal use varies considerably. In this regard, the Syrian Steppe may be divided into two parts:

(i) Al-Jezireh, which is supplied with water by its rivers, and

(ii) Badiat Al-Sham, where there are neither rivers nor streams, but where the water is supplied by rainfall runoff collected in small basins and the underground strata.

Water resources in the Steppe are developed through wells, with water held in impervious beds and Roman canals. The Range, Sheep and Steppe Department (MAAR) has an ongoing program of cleaning out wells and canal and increasing supplies of water for domestic and animal use. The Department, recognizing the danger from overgrazing and trampling of the rangeland by concentrating sheep near water developments, has also initiated a program of facilitating the hauling of water by Bedouin to their sheep rather overusing the water points available.

Wells

Wells in the Steppe may be classed as surface (Roman), ground (artesian), and accumulation wells.

Roman wells are shallow and limited in water supplies. In summer their water levels are reduced, although the water is clear and useable. Artesian wells are deep and produce an abundant supply of water, though in most cases this water is either sour or sulphuric. Accumulation wells, found at the edges of slopes, are located for the purpose of accumulating surface water runoff. These wells may be open or may be closed when not in use. They are small and limited in water resources.

Water held in impervious beds

These water developments are formed by flowing brooks and streams. There are two main kinds:

(i) Khabari are lowlands in which large basins accumulate water in winter. These basins dry up rapidly at the beginning of summer. All of them are turbid to clear, although some are fresh while others are salty.

(ii) Ghudran are small surface ditches where rainwater accumulates; they include pits which can be rocky or impervious. Small brooks may be found in pits where the ground is slanting. While the water is sweet, these resources are quite limited, for they dry up in summer.

Roman Canals

These canals receive water from the higher mountainous areas. Water passes between two rocky and impervious surface layers; when it reaches the borders of the Steppe, it either comes to the surface or pours into the basin of the Roman wells. These canals are being cleaned and returned to use by the Range, Sheep and Steppe Department (MAAR).

Surface Dams

There are about 22 surface dams in the Steppe. They were established to collect flood water and keep it for the longest possible period. The objective was to help control erosion, supply sheep with water, and to limit their movements for water. Unfortunately, because of continuous dry weather and the poor possibilities of filling these dams, they are of no great importance and there are big variations between their theoretical and realized reservation of water.

E. Rangeland Deterioration

Overgrazing, plowing land for cereal production and uprooting plants for fuel, as discussed earlier, have contributed to the deterioration of the resources of the Steppe. In addition, concern has been expressed about the net effect on the Steppe's resources of the methods designed for more effective use of these resources by Bedouin and their sheep. These include programs to maintain their flocks better through supplemental feeding, provision of opportunities to purchase trucks, cars and tractor-trailers for hauling feed and water, further developemnt of water facilities, and the necessary financing to accomplish these programs.

Overgrazing

As has been discussed, grazing pressures on the rangelands of the Steppe exceed the capacity for carrying the number of sheep for the periods of grazing used.

Having continued over a long time, overgrazing and trampling of the land by sheep have resulted in the disappearance of perennial grasses, which in turn has intensified the periods of pasture shortage. Perennials remain green and nutritious for a much longer time than annual grasses, which have increased and partially to almost completely replaced perennials. In addition, much land now bare at one time supported plants.

As a result of overgrazing and in the absence of control measures, the more palatable subshrubs, perennial grasses and legumes such as Salsola vermiculata, S. Lancifolia, Stipa barbata, Astragalus spp., Onobrychis spp., and others formerly common in the Syrian Steppe have been replaced by less palatable plants such as Noaea mucranata, Peganum harmala, and several spiny shrubs of very low forage value (Draz, 1974). Where Poa sinaica was the dominant species, overgrazing has brought about an increase in Carex stenophylla, a less-productive species. In the northern Jezireh some of the best forage grasses, legumes and forbs have been eradicated from large areas and replaced by weeds and spiny plants such as Poterium spinosum.

Carex stenophylla, mentioned above, a shortlived plant, comes in with overgrazing. This practically medible grasslike plant tends to eliminate the other plants, forming large homogeneous stretches which grow a bit wider each year. It can survive on rainfall of 100 mm per year and stand temperature above 50°C. and low winter temperature s (Pabot,1963). A real problem in range management occurs where this plant has become dominant. Whereas the protection of Poa bulbosa can prevent the disappearance of this species, the protection of areas heavily populated with Carex stenophylla would only help this undersirable species to spread. Under these conditions sheep would graze this plant, because it is the only pasture available.

With overgrazing have come not only the less palatable and less nutritious plant species, as the better plants have been reduced or destroyed, but also an increase in plants that are harmful to sheep or of no value for grazing. Peganum harmala is a poisonous perennial species found around villages at the edge of the Steppe, where overgrazing is most pronounced and in the Steppe where overgrazing has occurred. No palatable plants grow where it has taken root. In some areas Stipa carpensis is a harmful plant whose sharp seeds sink deeply into the animal's hide. This plant, while palatable at early growth, may be such a large part of the vegetation in places that some people think it is the normal vegetation.

Another widespread type of deterioration of the steppic flora is the development of certain inedible, annual or perennial Chenopodiacae species (Haloxylon, Anabasis, Salsola, Halocharis, Noaea, and others) which takes place on salty soils with a fair amount of salinity. Certain species can also invade very sandy soils or the grey soil of the Artemisia Steppe.

Perhaps the condition of the Steppe relative to the composition and capacity of its ranges can best be portrayed in the findings of Pabot (1963). He says that overgrazing and, above all, trampling of the land, have been responsible for the disappearance of the hardy steppic grasses and their replacement with Poa bulbosa, a shortlived grass which grows only during the rainy season. This bulbous grass met the needs of roving sheep for a long time, but it is in regression tending to disappear from vast areas. Being bulbous, it has to constitute reserves for the following year. Early overgrazing prevents this and the plant dies. In 1963 Pabot estimated that half of this pasture had been lost in the past 20 years.

Pabot further points out that as the more or less perennial hardy steppic species have been replaced by temporary turf, the soils deep down have become drier and drier; thus the desert begins from underneath.

Plowing in the Steppe

Plowing the natural vegetative cover has completely destroyed a number of valuable plant associations such as Poa sinaica, P. bulbosa, Stipa barbata, S. lagascae and these have been replaced by less productive annuals such as Hordeum murinum and Stipa carpensis, which are not reliable during drought years or dry seasons (Draz,1974). Under Syrian conditions reestablishment of the natural vegetative cover after plowing is a slow process. In many cases, unpalatable shrubs such as Anabasis syriaca have become the dominant species on previously plowed land.

While plowing in all areas receiving less than 200 mm of rainfall, was declared illegal in 1970 with modifications in 1973, plowing intensity in these areas is still high, for workable regulating methods have not been adopted.

Uprooting of Shrubs

Uprooting shrubs ofr fuel plays at least as harmful a role as plowing, not only by causing the disappearance of edible species in the summer, but mainly by making the microclimates still drier and favoring the wind's erosive action (Pabot,1963). Vegetation destruction is nearly total because plants are uprooted and no means for reproduction remain. The zones of denudation are especially evident around villages and camps, but the introduction of motorized transport has extended fuel gathering to great distances, thus extending the area of range deterioration. It is here that man comes into direct competition with grazing animals for the meagre range vegetation. This has been a problem for decades.

Developments Affecting Range Utilization

As mentioned earlier, sheep can graze on rangelands of the Steppe only to the extent water is available to meet animal and domestic needs. Fluctuations in rainfall affect supplies of water for both uses and also affect the amount and quality of the pasture available for grazing. Supplemental feeding programs have helped stabilize the extreme year-to-year variations in sheep numbers grazed on the range, these feeds making up the deficiencies in pasture production. Water developments, including the drilling of new wells, cleaning out old wells and canals, and the use of water trucks provide more water for the sheep, enabling them to stay for a longer time in an area and also to move into other areas where grazing had been limited because of the lack of water.

While these developments are conductive to use of a larger proportion of the rangeland resources, there is the danger that they may be overused. Although sheep are being watered and fed supplemental feed in scattered locations, there still may be evidence that additional areas are suffering overgrazing and

trampling which had not previously occurred. Also, with motorized transport, the Bedouin can identify potential pasture more readily and move their sheep by truck into the area. As discussed previously, range plants need some time during the growing season free from grazing in which to replenish their food reserves. Otherwise, rangeland deterioration occurs.

Another matter related to the incrased use of vehicules is the creation of roads. New roads are established by Bedouins driving over new routes for feed, water and to transport sheep. When one road develops deep ruts or becomes too rocky, the drivers move their vehicles over and establish an alternate route. While the loss of vegetation is minute, compared with the total in the Steppe, the danger is that soil may begin shifting by wind, and water run off accelerate, resulting in gully formation.

Soil Erosion

Soil erosion has occurred in many areas in the Steppe. Steeper slopes with thin, rocky soils denuded of vegetation have suffered sheet erosion, while among deeper and heavier soils in the sloping plains, gully erosion is active in some areas. Considerable runoff water and soil occur with the occasional heavy rains and the force of water is sufficient to destroy rather large earthern dams. The amount of soil loss can readily be seen by examing the basin of one of the dried-up reservoirs.

One can only speculate about the amount of soil loss from ranges of the Steppe and the effects of this loss to the vegetation on which the Bedouin and their sheep are dependent as well as siltation into its streams, rivers and reservoirs.

Wind erosion, always a possibility among the scantily covered, sandier soils, does not appear as much in evidence as does water erosion. However, fine silt and organic matter losses during windstorms, especially when the plant cover has been abused, is always a possibility, though not so dramatically portrayed except during the storm itself.

Grazing Capacity of the Steppe

In 1963 grazing trials were carried out at the Wadi Al A'azib Range and Sheep Experiment Station to compare the effects of different stocking rates on annual production and the composition and density of the vegetation (Vander Veen,1967). The preliminary conclusion drawn from these trials was that a stocking rate of 5 - 7.5 - 10 ha per sheep unit on the basis of 6 - 7 - 8 months of grazing with the provision of supplementary feed in periods of extreme drought or cold weather approached the carrying capacity in that location for that period of time. The three zones included 150-200 mm average

annual rainfall, 100-150 mm and 100 mm or less respectively. From this it followed that the Steppe can provide about 12.4 million sheep-grazing moths. without further deterioration, provided addiitonal feed from outside the range is given in drought years. In 1965 the Steppe had to provide about 33.6 million sheep-grazing months and even in the drought year 1966 grazing amounted to about 17 million sheep-months.

Van der Veen concluded that after regeneration the Steppe could accommodate about 3 million sheep for an average of 9 months per year, thus providing about 27 million sheep-grazing months.

F. Sheep Raising

Types of Operations

The systems of grazing sheep have been discussed earlier. Carrying these one step further, it becomes apparent that there are several types within each system. The small village flocks are combined into a larger flock of 200-500 sheep.

The owners in the village hire shepherds to herd and care for the entire flock. These flocks stay around the village and are not moved to the Steppe. There are also village flocks that go to the Steppe. Owners of sheep in this case may have from 300 to 800 sheep, and where there are larger flocks, they may be broken down into two flocks of 400 each. Herders are hired by the owners, who only take out the flocks that are dry. The Steppe flocks, those that stay in the Steppe or are moved to crop residues in the summer and fall, include small flocks belonging to families who own and manage 50-100 sheep, and large flocks, the property of families who own 500-300 sheep and hire shepherds to take care of them. The owner and his family deliver water, food and other supplies to the shepherds by truck or car.

Some private individuals and merchants in urban areas own sheep and hire Bedouin herders to care for them. In the past the Bedouin depended upon the wages and share arrangements for their livelihood, but more recent programs of credit for feed and the opportunities for earning income in the urban areas have enabled more Bedouin to own thier own flocks. Ties are still maintained between Bedouin, merchants and middlemen who assist in marketing the sheep products, However, indications are that dependency upon merchants and contacts in the urban areas for political influence is declining. Beoduin feel more certain of a hearing among Government officials now than in the past. At the same time, merchants are finding increasing opportunities for higher rates of return on their capital in enterprises other than sheep.

An estimated 70 percent of Syria's sheep are controlled by Bedouin, either owned outright or under some form of sharing arrangement. Thirty percent of the sheep are either owned or shared by people in villages or urban areas.

As of 1977, 46 Range Development Cooperatives with 11,194 members were located in the Steppe. These cooperatives are attempting to demarcate and map their grazing areas. The members are qualified to receive World Bank Loan finance in feed purchase and range improvement.

An estimated 20-25 percent of the Steppe is covered by these cooperatives. Some 131 sheep breeding cooperatives had been formed by 1977, although the 7,591 members do not qualify for World Bank Loans. These cooperatives lie outside the Steppe.

Sharing Arrangements

Two types of sharing arrangements are practiced in sheep raising:

(i) Base sharing, where the owner purchases the sheep and gives them to a shepherd who, together with his family, takes care of the flock. The shepherd pays the owners the price of the flocks from the lamb, milk and wool until he has paid for half the flock. From then on, sharing the products between the now equal owners of the flock becomes 50-50, with the shepherd still caring for the flock. This sharing arrangement apparently is not practiced as widely as it once was because of partner disputes concerning the arrangements and increasing herder independence.

This system was commonly found around Aleppo; now it appears mostly around Rakka.

(ii) Gnoomyeh sharing is more common around Hama. In this arrangement, owners purchase sheep and give them to the shepherds, although the flocks stay under the same ownership. The owner receives 2 kg of ghee per milking ewe and half the lamb crop, while the wool is given to the shepherd. The owner pays the counting tax for the milking ewes; the shepherd pays the tax for the dry ewes. When shepherds are hired to handle dry flocks, the sheep owner buys food, tobacco and other incidentals and pays the shepherd a salary of S.L.500-600 per month.

Type and Adaptability

The main breed of sheep in Syria is the Awassi, a fat-tailed, carpet-wool type, with brown or black face and legs free of wool. Wool on the body is mainly white, but the sheep have varying sized patches of black or brown irregularly over the body. There are some subbreeds or types in widely scattered areas, although the differences are minor.

Flocks developed to the northeast of the Euphrates are raised for meat while the sheep of central Syria are more frequently milk producers. Ewes are polled, some having short-horns, and rams are horned.

The Syrian sheep have developed through natural selection from the survivors of drought and consequent pasture shortages, diseases and parasites. The Awassi is able to graze closely to the ground, even to the extent of picking up fallen seeds from range plants and from harvested wheat and barley fields.

Products

Sheep are raised for meat, milk and wool, with the proportions of total value of products produced varying with production decisions related to distance from markets, pasture conditions in the Steppe, season of the year and prices. An early report cited these values proportionately at : meat, 57 percent, milk products, 28 percent, wool, 15 percent of the total value of annual sales (Shier, 1956). A later report placed these value ratios at 47 percent for meat, 41 percent milk, and 12 percent for wool (Khoury, 1965).

Meat sales and home consumptions is composed of lambs, which may be early (milk lambs) or range lambs, and some cull ewes and rams. Milk is used in the making of ghee (samneh or cooked butterfat), dried curd (hohot), cheese (gibneh) and yogurt. Little if any whole milk consumed fresh. Wool is shorn once in the spring.

Sheep Husbandry Practices

The Bedouin sheepman retains his ewe lambs for flock replacement and sells his ram lambs, except for those males kept for breeding. Some flock owners purchase replacement rams frp, other operators. The exportation of ewes is prohibited, with exceptions. At the Damascus slaughterhouse only lambs, yearlings and rams are slaughtered; however, at Aleppo ewes are slaughtered, many of them old or non-productive ewes, some fattened in feedlots.

Ordinarily Bedouin do not cull old ewes as long as they feel there is a chance of their having sufficient vigor and enough teeth to survive and produce another lamb. The shepherd can identify the ewes that are more productive and those of questionable productivity, but he is unaccustomed to applying this knowledge for culling.

Breeding

The common practice in breeding is to allow the rams to run with the ewes at all times; the ratio is about three or four rams per 100 ewes. As a result, the lambs are born over a period of four or five months. More progressive owners run their rams with a ewe lamb flock until the first of July, when they are introduced to mature ewes. The resulting late November, December and January lamb crop can take advantage of the desert grazing of February - April, when they are weaned.

Ewes bred while grazing on cropland stubbles are in effect being flushed before breeding. Ewes on mountain ranges during the breeding period are fed supplementally prior to breeding if the herders wish to shorten the lambing period, provided feed is available. If the ewes on range are not fed, the lambing period will last longer.

Lambing

In the Steppe generally there are three lambing periods: October-December; December through January and February through March. The early lambs are milk lambs sold for slaughter in April and May, while the mid lambs and late lambs, called range lambs, are sold June to September for fattening in feedlots before going to slaughter. If grazing conditions are good they may be taken back to the Steppe for grazing rather than being placed in feedlots. According to Faulkner (1978), birth weights average 4.4 - 4.6 kg for males and 4.3 for females. Weights at weaning average 29.9 kg for males and 26.4 females; yearling weights are about 45.6 kg and 39.5 kg, male and female, while mature weights average about 67 kg and 50.1 kg, respectively, for males and females.

The Awassi sheep are fertile in good pasture years with adequate nutrition. Twinning is rare, about 5-10 percent, although the ewes can lamb twice in one year. Very low lamb crop percentages were experienced during the drought of 1958-1960 when reports of 25 percent or lower were common (Wellington,1962). The Bedouin shepherd is skillful in caring for his ewes and lambs at lambing time, with resulting lamb crops of 60 to 90 and up to 100 percent.

Lactation and Milking

Lengths of lactation and milking periods vary according to feeds available, the milking ability of the ewes, and the time of lambing. Milk lambs suckle from birth until they are sold in April; thereafter, until dry, the ewes are milked. Range lambs suckle for one to two months, January and February. Beginning about March the lambs suckle a half day and then the ewes are milked once a day. In April all the lactating ewes are milked twice a day, while the lambs are left to suckle two hours after each milking. The lambs are weaned in May, while milking continues. By June half of the ewes are dry and by July all the milking ewes are dry.

An estimate of the annual milk yield per ewe is difficult to make because the milk is not ordinarily weighed, but it may be in the order of 22 kgs in average years (Wellington,1962). The milking ability of the ewe flock is customarily expressed in kilograms of ghee and in typical years it may average 2.5 kgs or higher when pastures are superior. Another estimate of yields indicates that under usual conditions yields are around 40 kg plus about 20 kg taken for the lamb (Faulkner, 1978). Fat content of the milk is about 7-7.5 percent.

Milk Processing

Little if any whole, fresh sheep milk is consumed by the Bedouin family or sold for direct consumption. Commonly the Bedouin family processes the sheep milk into ghee (samneh) or yogurt for home consumption or sale. Some of the Bedouin, those with larger flocks, may sell milk to a cheese maker who operates mobile cheese equipment. Few Bedouin make cheese themselves.

From early milking period until the end of April, milk is sold for cheese making for local consumption. The Bedouin also make yogurt. If the spring pasture is especially good, some Bedouin will make spring ghee, which is said to contain the taste of wild flowers. Generally, ghee is made late in the season when milk yields are lower and butterfat content is higher. Owners of small flocks or of flocks located some distance from roads and urban areas make ghee, for no cheese maker will come the them to purchase milk.

Wool Shearing and Handling

Some Bedouin shear their own sheep, particularly those staying in the Steppe near the borders of Iraq and Jordan who have little contact with the outside. Most Bedouin, however, hire shearers. The shearing occurs during a four to five week period beginning in May. Fleece weights average 2-2.5 kg for rams and 1.75 kg for ewes, with yields of around 50 percent (Faulkner,1978).

Shearing is commonly done by hand shears, the sheep being tied and thrown to the ground, which may or may not be covered with a mat or rug. During shearing and tying of the fleece into bundles a large amount of sand and dust is added to the fleece.

Sheep Health and Diseases

Lambing and breeding flock mortality rates are highly dependent upon rainfall and pasture conditions, but factors other than animal nutritional levels are also involved. While lambing rates may vary between 50-100 percent, lamb mortality rates may range between 8-60 percent (Faulkner,1978). Developments in supplemental feeding and improved water facilities have no doubt had a moderating influence on losses.

In addition to nutritionally related losses, there are production losses due to animal health problems, although the two are often part of the samething. Health problems cause an estimated annual loss of 15 percent in production. Government veterinary centers offer health service at the center and send teams to the grazing areas. A study by Wellington (1962) indicates that Bedouin owners call for Government veterinary services only after disaster strikes. However, use of veterinary services have been developed to an extent that sheep diseases and parasites are less serious. Two of the more threatening deseases, sheep pox and anthrax, may be controlled by vaccinating the sheep. Dipps and drenches are also available for the control of internal and external parasites.

G. Sheep Fattening in Feedlots

Importance of Fattening

With the development of feeding yearling lambs in feedlots, the supplies of meat have been increased much more than would have been possible through relying totally on ranges and pastures to produce for Syria's growing demand. At the same time, the fattening of yearling lambs and to some extent old ewes, relieves the Steppe's ranges of grazing pressures, leaving much-needed pasturage to support the breeding flocks. Further, development of the fattening industry stimulates establishment of marketing facilities and arrangements thus generally improving prices of male animals and old ewes and rams.

Location and Arrangements for Fattening

In Aleppo, Hama, Homs, Al-Rakka, Idleb and Deir-Ez-Zor these are several hundred small and large privately owned yards for intensive commercial feedlot fattening of sheep and some cattle. Some of these have operated for a long time. About 200 such yards were functioning in Aleppo in 1967, each yard with a one-time capacity of about 1,500 sheep. More private feedlots with increased capacities have been established since then.

Also, through a World Food Program assisted project, the Government is encouraging the fattening of Syrian sheep by providing credit at reasonable rates to small operators at fattening yards at Hama and Homs. These activities are being carried out through 56 cooperatives which in 1978 had 3,608 members. The Meat Bureau also has begun fattening lambs in an attempt to supply meat to the population center of Damascus.

Numbers and Sources of Sheep Fattened

Recent estimates indicate that approximately 3.5 million sheep are being fattened yearly in Syria's feedlots, 2.5 million of these consisting of local Awassi and one million being imported sheep. The imported sheep are brought in primarily from Turkey, Romania and Bulgaria.

In the private sector both individual operators and those belonging to co-operatives fatten local and imported sheep. Locally produced sheep, after fattening, may be sold to the Meat Bureau as requested or through private channels. Those who import sheep temporarily export then after the fattening period. Agreements entered into between the Government and individuals importing sheep for fattening and subsequent export include requirements that each lamb must weigh at least 45 kg and at least 20 percent of the lambs purchased be sold on the local markets after fattening.

An import-export tax of S.L.30 per head is charged the importer. The relatively lower prices for lambs in Turkey and other exporting countries and the higher than Syrian prices received live in the Gulf States and Saudia Arabia makes this systems of fattening quite profitable. Though foreign exchange is earned in these transactions, most of the beneficiaries are the several large merchants in Aleppo who bring in as many as 30,000 to 100,000 lambs each year. The importation plan, designed to minimize the amount of feed used, to increase foreign exchange earnings and also to increase the domestic supply of meat (the 20 percent requirement) has another aspect not entirely taken into consideration. Reports indicate that feedlot fattening technology is adequate or better, but that lamb death losses while feeding still reach 5 percent. These losses are made up by domestic sheep so that the original 80 percent of total purchase are still exported.

Fattening Systems

The fattening period varies from 70 to 100 days, averaging about 90 days, with replenishment rate of the yards 2.5 times yearly. Generally the sheep enter the yard either as yearlings or older. For the first 75 days they are given a mixture of ground barley (40 percent), wheat bran (40 percent), and cottonseed hulls (20 percent). The shares of hulls and bran is gradually decreased. Such a mixture is given for 2-3 months, and afterwards the sheep are finished for the final 20 days on grain only. Some feeders substitute chopped legumes hay for cottonseed hulls.

The average concentrate mixture composition is estimated at 1.35 kg per head per day and roughage 1 kg per head per day (Khoury, 1979). An average weight going into feeding is 30-35 kg at 6 months of age and ends with a going-out weight 56-60 kg, for an average gain of about .29 kg per day. Imported or local yearlings enter the feedlot at 45 kg per head and are finished at 70-80 kg.

Fattened local sheep usually are marketed during June - September, while imported and fattened sheep, those sold domestically (the 20 percent) begin entering the market in late August and most of them come in between December and January when meat supplies are at the lowest ebb.

Sharing Arrangements

Many merchants fatten sheep, the common sharing arrangement being for the merchant to buy the sheep and the feed, while the fattener provides the fattening barn, labor and management. The net gain is divided half and half.

H. Marketing

Marketing of meat, milk, milk products and wool occurs throughout the years, but is quite seasonal in part due to the production process, but also affected by range conditions in the Steppe.

The observation of the FAO/WFP Interim Evaluation Mission on WFP Assistance to Syria in 1972 describes the marketing problems associated with the interrelationship between sheep and range:

> The following adverse syndrome has resulted.
> In years of low rainfall, less natural grazing and livestock feed are available. High prices for feed grains and crop residues occur at the same time as meat prices as drought conditions necessitate an increase in sheep offtake and importation of feedstuffs. Smaller marketable meat supplies occur during the period of recovery following the drought year because flock owners tend to build up their flock...at high prices. Méat prices therefore increase which acts as a stimulus to imports. Improved weather conditions result in better growth of natural grazing, good grain harvests with increased supplies of feed grains at lower prices which in turn, results in increased meat and grain supplies at lower prices at lower prices for internal consumption and for exports. This cycle adversely affects both the terms of trade and balance of payments as livestock meat and grains tend to be exported at low prices and imported at high prices.

Under these variable and at times unstable conditions sheep producers are faced with many decisions. With range condition declining becaese of low rainfall, producers need additional feed for their sheep. To get the feed they must sell some of thèir flocks. The increase in marketing of sheep, in turn, lowers the price received. Conversely, when range conditions improve producers hold all their breeding flocks together and hold on to all their ewe lambs. As the flocks are being increased to their former sizes, marketing decrease and prices received for those animals sold increase. Thus, meat prices increase during good range condition years in the Steppe and decline during poor range condition years.

Sheep Marketing

The yearly marketing chain begins in February when old ewes with lambs are sold. The lambs are sold as milk lambs in April-May, while the ewes are fattened in feedlots for two to three months before slaughter (Fig.6). Beginning with this period there is no meat shortage in Syria, at least until December.

After April different types of lambs begin to appear. Milk lambs are slaughtered directly, while the range lambs in good condition go to slaughter in June-July after being fed for a short period on stubbles or in feedlots. Fair or poor range lambs are both fattened in feedlots or kept until yearlings. In good range condition years in the Steppe up to 30 percent of the range lambs will be moved back to range, where they are kept until they are yearlings. When they came back those in good condition are finished prior to slaughter, while the poorer yearlings are fattened in feedlots for two to three months. The fair and poor range yearlings are slaughtered August-November.

Culled sheep are marketed in June-July, these being the ones in good condition which were sold with their lamb in February. Those in poor and fair condition go to slaughter August-November. Relatively few culls are sold and these, being distributed through the year, have little effect upon the market.

Depending upon the year and range conditions, Syria begins having a meat shortage in late December which lasts until the end of March. Raw lambs imported during for fattening from Turkey, Bulgaria and Romania, but principally Turkey, in August-December begin moving to slaughter in December and continue until the end of March. At this time, these feedlot sheep, fattened in Syria, constitute most of the total meat supply.

The pattern of sheep slaughter by months may be seen in Fig.7, again pointing out the December-March meat shortage, despite the marketing of imported sheep fattened in Syria. Apparently the 20 percent of total number that are to be sold in the domestic markets, the remaining 80 percent being exported, are not nearly enough to equal the domestic marketings at other time of the year. Even here the 20 percent include losses which must be replaced by local sheep.

Market prices of sheep are variable, while retail meat prices are set by the Government. With variable supplies of meat, sometimes the prices of meat tend to be lower than the set price during periods of large supplies. When supplies are short, the price is difficult to control and the consumer often pays more than the set price or else he buys from outside the recognized and legal channels of trade.

Quotations on live-animal prices are difficult to obtain. Sheep prices during the past year are estimated as follows:

	S.L./head
mature ewe	250 - 400
yearling ewe	300 - 400
ewe lamb (6 mo.old)	150
breeding ram	400 - 500
ram for fattening	300 - 400
cull ewe	200 - 300

Strain:		S.L./kg Live weight
Awassi	Ram	10.00
	Fattened	9.25
Hamra	Ram	8.30
	Fattened	7.80
Garha	Ram	9.25
	Fattened	7.75
Billa	Ram	7.25
	Fattened	7.25

Producer Marketing of Sheep

Sheep raisers are highly dependent upon dealers to sell their sheep for them. Usually the producer takes his sheep to the markets, as in Homs, Hama and Aleppo, where for a fee the dealer finds a buyer, who also pays a fee to complete the transaction. Being some distance from the market and lacking market news and experience, the raiser is at a considerable disadvantage in negotiating for the best price possible for his sheep.

On the other hand, sheep fatteners deal for themselves or supervise some of the fatteners. Large feeders, including those who import sheep temporarily, appear to be quite adept at marketing their product. Members of Fattening Co-operatives, however, and some of those feeding fewer sheep and selling individually, are less skilled dealers.

Milk Marketing

The nature of milk production and processing is discussed on pages 63-5. The amount and timing of milk production, processing and marketing are highly dependent upon many factors, the main ones being range conditions in the Steppe, distance of the flocks from markets, and relative importance of milk to meat production.

The milking period begins in April and ends in July. Milk produced during this period may be sold to a cheese maker who collects the milk, sometimes twice a day, thus relieving the producer of the need to invest in cooling equipment. On the other hand, middlemen may pick up yogurt from the sheep operators closer to markets or ghee from operators farther away.

With no milk plants in the public sector that process sheep or goat's milk, the entire milk and milk-product marketing scheme is in the hands of middlemen. Apparently this system works quite well at present, except for concerns about lack of sanitation in handling. Consumers seem to prefer yogurt made from sheep's milk to that made from cow's milk. Also the white cheese made from sheep's milk is widely sought. Ghee, on the other hand, has been declining in favor of more digestable fat or possibly less fat in the diet.

Some ratios of conversions from milk to the various products include:

100 kg milk	=	6.7 kg ghee
100 kg milk	=	30.94 kg cheese

Retail prices of milk products for the last year were:

	S.L./kg
ghee	15 - 20 (27 in winter)
yogurt	2 - 3
cheese	7 - 10

Wool Marketing

Wool is sold to merchants in the urban areas who distribute it to local users, including the manufacturers of blankets, carpets and mattresses. Dealers, representing large exporters, also purchase raw wool. White and colored wool are sold at different prices, although similar types of wool tend to be sold at the same price irrespective of foreign material, and there is little incentive for improvement in wool-handling methods. Most of the raw wool is exported to the Soviet Union.

The Wool Scouring Plant at Hama, operated by the Syrian Government and UNDP, opened in 1977, scouring 200-300 tons. During 1979 an estimates 1200 tons had been scoured. The average price paid for wool is about S.L.5/kg in the grease and the yield 46-47 percent. The plant is having difficulty obtaining adequate supplies for scouring, but also in getting the grit out. The washers are designed for high-fat content and low-grit content, while Syrian wool requires the opposite arrangement. Personnel at the plant sort and grade the wool. They cite wool clips of 1 kg head clean, when it should be 3 kg head clean.

Most of the wool handled and used locally is hand washed, the fleeces stretched out to dry, even on asphalt roads, where vehicular traffic sometimes runs over the fleeces.

Skins

Little written information is available about the handling and marketing of skins. They are useful, essential products and they constitute a commodity for export. Over the past several years, market prices for skins have risen, in part because of the high price for synthetics and the inferior quality of synthetics for many purposes. Sheep producers give some thought to the value of skins, for apparently by having sheep slaughtered outside the recognized slaughterhouses they get a better price for the skins.

I. Proposed Plan for Development of the Syrian Steppe

Problem

Rangelands of the Steppe are used for sheep production by Bedouin families and others, including farmers and merchants who bring sheep in from outside the Steppe. Despite Government programs initiated in recent years to upgrade the level of living among the Bedouin, to control the use of rangelands and to facilitate improvement, evidence suggest that rangeland deterioration is continuing and perhaps may be accelerating. Temporary gains to Bedouin sheep raisers and fatteners through easier credit to buy feed and vehicles and to graze on assigned lands may be short-lived as the full impact of resource depletion catches up.

Specific aspects of the problem may be further described:

(i) While the marking of established grazing areas is being done and ranges are being mapped, progress has been slow and may not have encompassed the goal of 20 percent of the Steppe set by Government.

(ii) Grazing capacities, where determined, are not being used to get sheep numbers and grazing periods, that is, the total grazing pressure, in line with rangeland productivity.

(iii) While feed is allocated on the basis of the number of sheep, not to exceed 60 head per person, many Bedouin have more than this number; therefore they spread the use of the feed over the larger numbers. This program apparently has little effect on limiting the number of sheep held, which in turn leaves larger numbers of sheep in an area longer, without adequate pasture, to the detriment of the range resource.

(iv) Investments in cars, trucks, tractors, water tanks and the development of additional water facilities, all tools for the proper use of rangelands, are not being coordinated with other programs, especially those geared to bring sheep numbers and grazing pressures into line with rangeland productivity.

(v) Trespass grazing reportedly is still occuring, despite markings of recognized Hema Cooperative boundaries.

(vi) Uprooting of shrubs for fuel is still being practiced and even expanded into areas distant from Bedouin camps and villages because of increased use of trucks.

(vii) Reports indicate some of the marginal areas of the Steppe, and even areas deep in the Steppe, being plowed and the total area plowed may be increasing.

(viii) Hema cooperatives, the main purposes being to delineate range areas and limit grazing, are too narrowly based. The main attraction for membership is the purchase of feed or vehicles, and membership composition seems to be more concerned with these limited economic interests, rather than broader economic interests such as marketing activities, or with family and tribal goals in general.

(ix) Without a sound, coordinated base of individuals, tribal and governmental programs leading to economic development of the sheep industry and rangelands, together with programs of establishing schools, medical facilities, roads and utilities are likely to be unevenly or unwisely applied. In addition, through lack of coordination, opportunities to develop rural industries based on sheep and their products are being neglected.

Objectives

(i) Establish an organization for the Steppe Development as GADEB, supervised by a High Council to coordinate the activities, particularly planning in the beginning, of all the ministries with activities in the Steppe. This orgainzation would take over the technical work now done in the Steppe by the Ministry of Agriculture and Agrarian Reform.

(ii) Establish Mohafaza ministry offices at a designated center. Suboffices of each ministry would be located in centers designated on the basis of being at the same location as schools, hospitals and other facilities serving the Bedouin. All ministries would not necessarily be located in the centers, depending rather on the type of economic and social development activity that seems plausible.

(iii) Establish a Mohafaza to encompass the entire Steppe. This would reduce the number of Mohafaza governments which are currently involved in administering programs for people in the Steppe and also administering programs that apply only to those in the more humid and more highly developed areas. Bedouin would tend to have more contact and take more stock in a local government that is familiar with their way of life and would devote full time to their special needs and to resource problems that exist only in the Steppe. Mantika could remain as now defined, although attention should be directed toward the designation of centers which would include schools, hospitals, and other facilities to serve people living and moving over rather large areas. This would be a gradual process which could logically evolve after the duties and functions of the High Council and various ministries become established and become evident.

Ministry Responsibility in Steppe Development

Ministry representatives would perform the management functions of formulating expectations of what can or should be done, devising plans in which development alternatives are examined, assisting the Bedouin and other producers in putting the plans into effect, and finally, evaluating the results of plans varried out and making such modifications as necessary. These responsibilities would be parcelled out to the Ministries concerned, in some instances more that one for each specific planning alternative. In any case, a massive, comprehensive study by all Ministries, coordinated by the Council for Steppe Development would need to be undertaken before decisions were made.

Ministry of Agriculture and Agrarian Reform

The Ministry of Agriculture and Agrarian Reform would undoubtedly be involved in more aspects of Steppe developments than any other ministry.

The Directorate of Range, Steppe and Sheep would study the grazing resources, evaluating ranges in terms of conditions, trends, and opportunities for improvement, at the same time determining proper stocking rates and seasons of use. In the meantime, Rangeland Management Areas, areas with similar vegetatives, soil and climatic conditions would be identified, mapped and placed under control for allocation of grazing and reviewing and correcting of stocking decisions. Particular attention would be paid to the allocation of plant materials (Atriplex spp. and adaptable perennial grass species) to Bedouin who graze sheep in their respective Hema cooperative grazing areas and in the Rangeland Management Areas. Assurance of protection from grazing for the recommended time would be obtained before any sizeable improvement treatments were applied.

The Directorate of Animal Husbandry would be involved in detailed surveys to determine current sheep production and marketing practices, costs of production and the examination of profitable adjustments. At the centers this Directorate, in cooperation with the Range, Steppe and Sheep Directorate, would make integrated studies of sheep production and grazing systems on large enough grazing areas to determine the most profitable methods of producing sheep where a large proportion of total feed comes from range. The Directorate of Animal Husbandry would be separately involved in upgrading the Awassi sheep for meat, milk and wool production, and placing superior sheep in the hands of the better Bedouin sheep operators.

Other Directorates (MAAR) likely to be involved in development of the Steppe include Animal Health, Agricultural Engineering, General Organization for Fodder, Land Use, Planning and Statistics, and State Properties. Of particular importance would be the Peasants' Union, which would have a major role in development and operation of the cooperatives, which could be expanded to include marketing functions.

Not to be overlooked at the Steppe Mohafaza and Center levels would be the role of a strong and active Extension Service. Coupled with the research teams involved in examining potential development possibilities, Extension Service personnel would meet with Bedouin groups to determine attitudes about desired goals and how best to achieve them. The Extension function would be needed at all stages of development.

Ministry of Public Works and Water Resources

The Ministry of Public Works and Water Resources would initiate a study of the unsurveyed surface and groundwater resources of the Steppe. Information would be presented to the Council and to other Ministries concerning water amounts, quality, and suitability for various uses, whether for domestic use by Bedouin families for livestock or irrigation. Of particular importance would be the location and development of water supplies at the Centers and at strategic locations for improving grazing use of the Steppe's rangelands.

This Ministry would work closely with the Ministry of Agriculture and Agrarian Reform (Range, Steppe and Sheep Directorate) in planning for development of livestock water, but also for the development of irrigation where soils are suitable for raising fodder crops to be used in sheep production on the Steppe.

Ministry of Health and General Welfare

The Ministry of Health and General would have major responsibility in determining kinds of health services needed and available and in preparing plans for expanded health delivery systems. Working through the Council and with other Ministries, this Ministry would develop plans for suitable hospital units in accordance with the needs at the Centers, but also for Bedouin shepherds and families who at times range far away from the Centers.

Ministry of Education

The Ministry of Education would locate suitable Centers to provide education and educational facilities for a partially to highly mobile population. In addition, it would have the responsibility of providing teachers willing to work in the Steppe both in children's schools and with adult education programs. As special rural industries develop the Ministry would have a major role in vocational education programs for development of special skills.

Ministry of Labor and Social Affairs

The Ministry of Labor and Social Affairs would have the main task at first of studying the social structure of the Bedouin, their goals and aspirations, and the degree of adjustability they posses in order to participate in the development plans for the Steppe. The Ministry would cooperate fully with the Extension Service, for each would have a planning and information function relative to the formation and presentation of opportunities for development.

Ministry of Industry

The Ministry of Industry would have a major role in locating Centers, design and construction of such things as school and health facilities and warehouses. In addition, certain rural industry development would depend greatly on the design and construction services furnished or arranged by this Ministry.

Ministry of Transportation

The Ministry of Transportation would be highly dependent upon the overall plans for Steppe development. For this reason, full sets of development plans would have to be completed before a network of roads could be designed and the manner, mode and amounts of public transportation determined. With the increase in vehicular use already apparent in the Steppe, this Ministry would need to evaluate the impact of increased travel on the life of the Bedouin, their economic well-being, and the effects of informal road systems on soil erosion. In these matters the Ministry would work closely with the Ministries of Agriculture and Agrarian Reform and Labor and Social Affairs.

Ministry of Supply and Home Trade

The Ministry of Supply and Home Trade would be involved in Steppe development planning, for this Ministry has a voice in determining prices and price policies for many products, including those produced or with production potentials in the Steppe.

J. Suggested Projects for Evaluation

Development of Mobile Milk Handling Systems

Hardly any of the sheep's milk is wasted. The distance from markets, the large number of sheep flocks from which milk is obtained and the absence of milk-cooling and collection units, however, often result in lower economic returns to Bedouin sheep raisers than otherwise might be possible.

Mobile collection and preservation systems could be used to pick up milk from numerous flocks, keep it fresh in refrigerated storage tanks, and deliver it to a milk processing unit for making cheese, yogurt, butter or ghee.

Feasibility studies of this project would include determination of the type, size and location of collection units, taking into consideration ownership and operation by cooperative members. Of primary importance in the evaluation would be the relative prices of milk and milk products and the costs of collection by mobile units.

Development of Milk Processing Units

Milk processing units, small mobile or stationary, or perhaps large stationary plants, would be constructed or purchased and ready for operation as the mobile milk-handling systems come into use. The determination of the type of units, their location, and arrangements for moving milk products needs a detailed feasibility analysis.

Of concern in this analysis would be the location and particular demands of the market, the volume of milk that can be collected for processing, the variation in volume resulting from change in range conditions and the prices of lambs the main plants or systems of small plants and their optimum location relative, to supplies of milk and markets for milk, thereby minimizing transportation costs. Such plants would be constructed and operated by the Government, except in the case of small mobile processing units, which could be purchased and operated by one or several cooperatives.

Sheep Marketing

Marketing of sheep would be performed through pooling of sheep by each cooperative and perhaps by more than one. Flocks going to market would be sorted according to uniform characteristics, that is, range lambs rams (good condition), milk lambs, cull ewes, etc. Direct contacts with buyers could be

Sheep raising budgets would be developed from the information obtained, one for each significant situation, measured in terms of the number of Bedouin and the number of sheep included in the particular system.

The resulting budgets would be useful in identifying research problems which, if solved, could be of benefit to the Bedouin sheep raisers. Certain practices could also be identified to increase profitability of the sheep enterprise or increase the efficiency of range use and doster range improvement.

These sheep raising budgets could be updated annually for changes in prices paid for inputs and prices received for sheep and sheep products. However, changes in pasture availability relating to fluctuations in weather would have to be estimated until another survey is conducted. Pricing policies and practices relating to sheep and sheep products and feed could be viewed in the light of the Bedouin economic condition in any one year. This would be a major reason for initiating this project.

The Directorates of Steppe, Range and Sheep Animal Husbandry, and the Central Bureau of Statistics and the Extension Service should have major roles in this project.

Proposed Establishment of Grazing Management Areas

Hema Range Development Cooperatives are reported to have about 20 percent of the Steppe marked off and under controlled systems of grazing. The degree to which grazing can be regulated and improved on rangeland assigned to each cooperative and on rangeland of the 80 percent of the Steppe not yet assigned to cooperatives is a critical question. Evidence supports the answer that rangeland deterioration is accelerating; therefore sound management programs need to be applied as soon as possible.

This calls for a grazing management unit approach, not to interrupt the progress made under the Hema Range Development Cooperative System, but rather to facilitate further development, and at the same time to manage rangeland not yet under control by cooperatives. Each Grazing Management Area would encompass rangeland of the Steppe with similar soils, vegetative and climatic conditions. It would be contiguous and of a size that would allow ready access for mapping, range surveying, and monitoring of grazing by a staff of range and animal husbandry technicians.

Once established, these Grazing Management Areas would be mapped according to vegetative types, but also according to range site and condition classes. Key grazing and indicator species would be identified, range condition trends estimated, and change related to weather and grazing would be recorded over time. A grazing plan would be developed whereby the number of sheep and the time allocations for grazing would be set for average, below-average and above-average rainfall years. Particular attention would be given to stocking rates and periods of use related to range condition trends.

These duties require a rather large field force, particularly during the grazing season, but also a small group to remain in the Area yearround. The Grazing Management Area personnel would issue permits for grazing to the Hema Range Development Cooperative members, whose rights have been recognized, to the extent these rights encompass the Area. More than one cooperative could be involved and perhaps several. Other sheep raisers who have grazed sheep in the Area in the past owuld be issued temporary grazing permits until their affiliation with a cooperative becomes complete; than a permanent permit would be issued.

Permits for grazing would be issued for a certain number of sheep-unit months, with these and beginning and ending dates subject to change, depending upon weather and pasture conditions. Recognition would be made of the availability of supplemental feed, particularly in drier years, but overgrazing would be prohibited. Thus, Bedouin sheep raisers would know their limits in sheep-unit months and could decide for themselves whether to carry yearling rams, ewes or mixtures of the two. In any event, they would be encouraged to cull their flocks of nonbreeders and inferior types rather heavily to stay within the permit limit.

Given the fairly long distances many sheep in the Steppe are moved, it is reasonable for many sheep raisers to have permits to graze sheep in more than one Grazing Management Area. In these cases, the issuance of permits would be coordinated among the Areas concerned, and the total sheep-unit months of grazing be balanced from one Area to the other.

An important function of the Grazing Management Area staff could be the monitoring of unauthorized plowing in the Steppe. This could be done very well first-hand on the Area concerned, but could be facilitated by use of aerial photography and remote sensing devices. The staff of the Grazing Management Area would be professionally trained, with student trainees and research assistance from the colleges and universities of Syria. Subprofessional workers would include drivers, field aides and others. The staff would work as technical advisors to sheep raisers and, although they would enforce grazing restrictions and issue permits, they would not in any way be looked upon as range guards. Nevertheless, they would be empowered with right to revoke permits, to reduce permitted use, and to remove trespass sheep and their shepherds from the Area.

Recommended size of the Grazing Management Areas would relate to many factors, including the availability of personnel and vehicles, the state of roads, nature of water facilities, and other conditions. As a beginning, thought could be given to the Resource Planning Unit (RPU) concept currently being used in the Agricultural Assessment Project for the Government of Syria in defining Grazing Management Areas. An RPU is a geographically delineated unit relatively uniform in land forms, kinds and patterns of soil bodies, climates, water resources, and potential vegetation, RPUs serve several purposes. They divide the landscape into natural, physiographic planning and implementation units. They serve as reference points for field technicians and provide planners with a device to screen development options.

These are approximately 10 RPUs in the Steppe. It wouldn't at this point seem possible to perform the duties outlined with fewer than 10 Grazing Management Areas. This means suitable living quarters, vehicles and equipment for at least 10-15 technicians at each station. While bonuses could be added to salaries to attract capable people for work in the Steppe, the development of a certain esprit de corps among the technicians would be of value also.

Research and Extension Proposals for Range and Sheep Stations

Range and Sheep Stations at Wadi Al-Azib, Twal El-Aba, Shoula and Um Madfah would be involved with both animal husbandry and range management research and extension. In addition to breeding and selection programs being conducted with Awassi sheep and disbursement of higher types among Bedouin sheep raisers, would be the handling of flocks in ways to:

(i) Carry sheep in numbers compatible with range productivity, making allowances for some supplemental feeding;

(ii) Reduce breeding and lambing periods and have lambs weaned before pastures begin to dry;

(iii) Initiate culling rates among breeding flocks, perhaps as much as 20 percent annually, upgrade sheep and increase production rates per ewe and per hectare grazed;

(iv) Study particular milking routines so that sufficient data are available to reflect the impacts of early milking, once-a-day vs twice-a-day milkings, and late milking lamb performance on range and subsequently in fattening feedlots. Data would be collected in form suitable for economic analysis;

(v) Milk collection techniques should be tested, the quality and quantity of milk recorded, and the yields of milk products determined at each stage of milking. These data would be collected and evaluated, thus providing a basis for decisions about milk processing under conditions of changing supplies as affected by range conditions and considering changes in relative prices of the several milk products.

(vi) Initiate stocking rate, season of grazing and rotation grazing studies, observing sheep production rates and range condition trends. Data would be obtained overtime so reliable systems and methods of grazing would be evaluated economically and put in the form of recommendations to Bedouin sheep raisers in the area. As studies are being initiated, care should be given by research personnel to see that key Bedouin leaders are informed of research plans and, together with Extension Service representatives, discuss the plans in detail. This procedure would enhance the chances of the research being related to the needs of the sheep raisers, while providing them with incentives to follow the research as it progresses.

Extension Service personnel would have major leadership responsibilities in periodic field tours of research facilities and projects. Also, adult education classes would be held at the centers, where many subjects could be covered, including such things as range management principles, plant identification, sheep husbandry and health problems.

Interactions between strictly academic personnel and those in the ministries charged with research and extension missions seem to be sorely lacking. Therefore, it is felt that efforts to encourage university range management, plant taxonomy, plant ecology, animal husbandry and nutrition specialists, and the like, to participate in research and extension programs established at the range and sheep stations should have a high payoff.

Proposal for Revegetation of Plowed and Deteriorated Lands of the Steppe

Considerable progress has been made with the planting of the semi-desert shrub, *Atriplex, spp.*, both native and introduced species (Sankary, 1978). Many studies have been done also with perennial grass species, native and introduced. Plantings have generally been more successful in areas of the Steppe with higher average annual rainfall. These higher rainfall areas are where plowing is most likely to have occurred and where overgrazing effects on native plants are the most pronounced. One method of controlling plowing and undoing some of the damage already done would be to initiate a massive revegetation project in these marginal barley areas where the chance of success is quite high. *Atriplex spp.* and perennial native grass species such as *Stipa barbata* could be planted in the same vicinity, for indications are that pure stands of *Atriplex spp.* are not conducive to good sheep performance. Also, the inclusion of more than one species would enhance the chances of a successful planting.

These revegetation programs would be successful in areas receiving an average of more than 250 mm of rainfall, and there only if grazing use is eliminated for at least two years following establishment, and there is careful grazing management afterwards. Therefore, these projects would be assigned to personnel of the Grazing Management Areas, where they would work closely with the Bedouin sheep raisers, and sometimes cereal crop producers, to gradually transform the use of these potentially productive grazing lands. Certain other rangelands, depending upon RPU designation, may have potentials for revegetation, if not to perennial grasses, then perhaps to *Atriplex spp*. These lands would be identified and trials made. Careful attention would be paid to the costs of revegetation and the returns forthcoming through grazing by sheep.

Proposal for Management of Surface Water Runoff

Considerable concern exists among range management professionals and others in Syria about the undue loss of the limited rainfall received in the Steppe. This accelerating runoff of surface water, accompanied by soil erosion, resulting largely from lack of vegetation on most range sites in the Steppe, but also in other regions, can be alleviated more properly through improved grazing management, which allows native vegetation to increase in population and growth. The additional vegetative cover is paramount for the interception of rainfall, particularly the high intensity rains that often occur, and in facilitating the retention of water where is falls, thus allowing deeper penetration of water into the soil.

Certain areas have potentials for mechanical methods of erosion control, such as pitting, contouring, water spreading, and chiseling. However, these practices are expensive relative to potential returns, particularly in the short term. Therefore, consideration should be given to these mechanical treatments only under certain conditions. The general area treated should be deferred from grazing during application and for two to three years afterwards. Then, livestock should be allowed to graze in accordance with range productivity. The sites selected should be few in number and located in suitable areas representative of significant parts of the Steppe. Accurate cost accounting methods for a few pilot projects, include a record of benefits received, would indicate the timing and extent of subsequent mechanical treatment of similar range sites in the Steppe.

Unless more careful livestock and range management practices are adopted simultaneously, there can be little chance of success with these mechanical treatments for improving ranges and reducing soil and water runoff.

Proposal for Development of Forage Production on Croplands

Much consideration has been given by MAAR and others to the possibilities existing for the utilization of fallow lands for the production of forage and other crops without subsequent decreases in yields of subsequent crops. In addition to providing nitrogen to the soil, leguminous crops in the rotation offer a vast potential for alleviating the feed and forage shortage that plagues the livestock industry.

Efforts should continue to determine suitable leguminous crops for use in rotations, to determine the effects of these forage crops on subsequent crop yields, to identify and overcome such limiting factors as inadequate labor supply, lack of mechanical harvesting equipment, and uncertainties of transportation and marketing systems. Development of an integrated program for grain crop - hay crop - livestock production possibly offers one of the greatest opportunities for increases in crop, forage and livestock production, while at the same time reducing grazing pressures on rangelands.

Proposal for Development of Range Plant Taxonomic Guides, Handbooks and Herbarium

Range plant colletions, taxonomic guides, range handbooks and herbaria are in various stages of development, located at different places. The Steppe Range and Sheep Department, the Arab Center for the Studies of Arid Zones and Drylands, the Soils Departments (MAAR), each have reports, handbooks, taxonomic guides and at least small range plant collections. The quality of the herbarium of the Soils Department Plant and Ecology and Classification Center at Douma is impressive, and staff is well-trained and interested in performing services to all technicians and Ministries involved in Steppe development. Coordinated with universities, Ministries, ACSAD, and ICARDA, efforts should be made to consolidate efforts in this field and to expand the herbarium facilities at Douma.

Proposal for Establishment of a Central Agricultural Library

Experience indicates there is a considerable wealth of books, reports, journals and magazines containing valuable information about the range-livestock industry of Syria. Many of these sources are scattered among university and ministry libraries, while others are possessed by individuals with special subject matter interests. One hardly needs to mention the advantages of having copies of these various materials at a central location where they would be readily available to research, extension and teaching personnel.

Therefore, it is proposed that such a library be established and staffed with specialized librarians who can make these materials available to all persons interested. Consideration should be given to including the proposed herbarium and its reference materials at the same location.

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TABLE 1. Land utilization by stabilization zones, SAR 1975[1/]

Agricultural Stability Zones	Total Area	Land Use: Forests	Land Use: Steppe & Pasture	Uncultivable Land	Cultivable Land	Total	Cultivable Lands: Uncultivated	Cultivable Lands: Cultivated	Total	Cultivated Lands: Fallow	Cultivated Lands: Under Crops irrig.
	1,000 Ha.	Percent									
First	2686	9.9	7.0	17.0	66.1	100.0	15.8	84.2	100.0	10.0	10.5
Second	2464	.2	5.8	12.9	81.1	100.0	2.8	97.2	100.0	38.4	8.5
Third	1335	.3	15.6	14.5	69.6	100.0	2.7	97.3	100.0	43.1	10.1
Fourth	1907	.2	34.0	11.4	54.4	100.0	10.8	89.2	100.0	51.8	5.6
Fifth	10126	1.6	73.5	22.8	2.1	100.0	3.3	96.7	100.0	4.8	100.0
TOTAL	18518	2.4	46.6	18.8	32.2	100.0	8.0	92.0	100.0	32.4	13.9

1/ Central Bureau of Statistics, Statistical Abstract, 1978

TABLE 2. Numbers of the major kinds of livestock, 1971-1977, and by Mohafazat, SAR 1977 1/

Year and Mohafazat	Sheep: milked sheep	Sheep: non-milked sheep	Sheep: Total	Goats: milked goats	Goats: non-milked goats	Goats: Total	Calves	Cattle: Oxen bulls	Cattle: milked cows	Cattle: other cows	Cattle: Total
							1,000				
1971	3088	2368	5456	431	310	741	139	71	174	122	506
1972	2993	2173	5166	429	268	697	142	53	185	108	488
1973	2822	2018	4840	390	218	608	144	45	188	117	494
1974	3267	2028	5295	453	231	684	141	48	215	120	524
1975	3815	1994	5809	543	271	814	144	43	243	127	557
1976	4233	2257	6490	632	324	956	158	34	257	125	574
1977	4239	2831	7070	683	327	1010	185	35	292	127	639
1977											
Damascus	223	140	363	140	64	204	41	3	52	17	113
Aleppo	728	500	1228	110	62	172	7	1	10	3	21
Homs	703	383	1086	30	20	50	24	8	43	20	95
Hama	728	553	1281	44	27	71	12	1	32	17	62
Lattakia	15	11	26	14	11	25	17	7	24	15	63
Deir-ez-Zor	249	371	620	28	15	43	11	-	23	12	46
Idleb	247	167	414	59	33	92	13	2	13	6	34
Al-Hasakeh	574	324	898	75	15	90	13	1	23	6	43
Al-Rakka	493	178	771	34	18	52	1	-	1	0	2
Al-Sweida	91	44	135	61	27	88	4	1	8	5	18
Dar'a	146	42	188	61	19	80	9	-	23	8	40
Tartous	18	12	30	21	13	34	28	11	36	17	92
Queneitra	24	6	30	6	3	9	5	-	4	1	10

1/ Central Bureau of Statistics, Statistical Abstract, 1978

TABLE 3. Animal products produced and production of milk and its derivatives 1971-1977, and by Mohafazat, SAR 1977[1/]

Years and Mohafazat	Hair	Wool washed	Milk produced: Buffalo	Goat	Sheep	Cow	Total	Milk and its derivatives: Butter	Cheese	(Samneh) Ghee	Consumed Freshmilk
	Ton		1,000 Ton					Ton			1,000 Ton
1971	533	6443	1	53	188	199	441	2045	27758	5530	157
1972	438	6071	1	48	223	187	459	1353	26640	7836	141
1973	355	5497	2	40	173	179	394	1092	24084	2166	134
1974	353	7114	1	52	235	212	500	1269	25832	7993	176
1975	481	6170	1	53	250	263	567	1283	29862	8911	200
1976	459	6560	1	72	285	307	665	1083	34550	9180	245
1977	467	6834	1	71	240	335	647	839	30160	7586	253
1977											
Damascus	45	361	-	14	13	125	152	6	4400	313	86
Aleppo	158	1225	-	17	51	12	80	22	5946	776	21
Homs	16	700	-	3	48	46	97	96	3944	1833	42
Hama	33	1280	1	5	37	23	66	119	4827	845	15
Lattakia	7	27	-	2	2	28	32	115	815	65	22
Deir-ez-Zor	30	775	-	2	10	21	33	103	863	614	15
Idleb	38	419	-	8	14	11	33	22	2432	291	5
Al-Hasakeh	20	870	0	3	14	11	28	-	1846	628	6
Al-Rakka	37	785	-	2	30	1	33	-	2577	839	7
Al-Sweida	39	137	-	6	6	8	20	-	796	476	2
Dar 'a	16	188	0	6	11	17	34	-	603	493	15
Tartous	23	36	-	2	2	30	34	356	990	234	17
Quneitra	5	31	-	1	2	2	5	-	121	179	0

1/ Central Bureau of Statistics, Statistical Abstract, 1978

TABLE 4. Slaughterings, carcass weight and production of meat irrespective of origin of animals, SAR 1976[1/]

Kind of meat	Number slaughtered	Carcass weight	Production
	1,000	Kg/Animal	1,000 mt
Mutton & lamb	2,800	18	48
Beef & veal	125	110	14
Goat meat	450	17	7
Poultry meat	-	-	20
Other meat			5
TOTAL			94

1/ The International Center for Agricultural Research in the Dry Areas, Report on Livestock Husbandry Research and Development in ICARDA's Programme of work, June 1978.

TABLE 5. Current estimated total annual production of crops, including residues pasture and range, for use in livestock production, dry matter basis, SAR

Crop	Area (1977)	Yield/HA Av. (1971-77)	Production	Grain		Straw		Residues			
				Factor	Grain	Factor	Chaff	Factor	Stubbles	Factor	Amount
	1,000 HA	Ton	1,000 Ton		1,000 Ton		1,000 Ton		1,000 Ton		1,000 Ton
Wheat	1528	1.14	1742	.01	17.4	.1	174.2	.5	871.0		
Barley	1021	.61	623	.90	560.7	.1	62.3	.5	311.5		
Maize	26.2	1.94	51	.50	25.5			.6	30.6		
Millet	24.9	.72	18	.50	9.0			.7	12.6		
Lentils	117.3	.71	83			.8	66.4				
Chickpeas	41.1	.63	26			.8	15.6				
Dry broad beans	8.0	1.49	12			.8	9.6				
" haricot "	6.1	1.57	10					.7	7.0		
Peas	.8	.84	1					.8	.8		
Dry kidney beans	1.0	.88	1					.8	.8		
Rambling vetch	38.5	.74	28					1.0	28.0		
Flowering sern	16.6	.83	14					1.0	11.0		
Bitter vetch	27.4	.59	16					1.0	16.0		
Peanuts	10.9	1.78	19							.3	5.7
Sunflower	5.0	1.11	6							.5	3.0
Cotton	186.5	1.93	360							.5	180.0
Sugar beets	12.2	24.11	294							.1	29.4
Pastoral crops	13.9	3.60	50								
Fallow land	1776	.1	178								
Range	7442	.2	1488								

TABLE 6. Estimated current annual production of crops including straw, residues, pasture and range, and by products used in total livestock production and total sheep production, TDN measure , SAR

Source	Total Amt.	Used by Livestock Factor	D.M.	TDN	Total TDN	Used by Sheep Factor	TDN	Total	Proportion
	1,000 ton	Pct	1,000 ton	Pct.	1,000 ton	Pct	1,000 ton	1,000 ton	Pct.
Seed Grains								220.2	14.8
Broken wheat	17.4	100	17.4	78	13.6	20	2.7		
Barley	623.0	90	560.7	76	426.1	50	213.1		
Maize	51.0	50	25.5	82	20.9	0	0		
Millet	18.0	50	9.0	78	7.0	0	0		
Rambling vetch	28.0	100	28.0	75	21.0	10	2.1		
Flowering sern	14.0	100	14.0	75	10.5	10	1.1		
Bitter vetch	16.0	100	16.0	75	12.0	10	1.2		
Straws								26.2	1.8
Chaff (legume)	91.6	100	91.6	55	50.4	20	10.1		
Chaff (cereal)	236.5	100	236.5	34	80.4	20	16.1		
Stubbles								323.9	21.8
Wheat & barley	1182.5	100	1182.5	30	354.3	90	319.3		
Legumes	66.6	100	66.0	54	36.0	10	3.6		
Corn	43.2	50	21.6	46	9.9	10	1.0		
Residues								73.1	4.9
Cotton	180.0	100	180.0	43	77.4	90	69.7		
Sugar beet	29.4	100	29.4	54	15.9	20	3.2		
Sunflower	3.0	60	1.8	40	.7	0	0		
Peanuts	5.7	100	5.7	40	2.3	10	.2		
By-Products								94.1	6.3
Wheat bran	110.0	100	110.0	59	64.9	40	26.0		
Sugar beet pulp	20.0	100	20.0	66	13.2	60	7.9		
Cotton seed cake	110.0	100	110.0	62	68.2	50	34.1		
Cotton seed hulls	60,0	100	60.0	51	30.6	80	24.5		
Sunflower seed cake	1.33	100	1.3	65	.8	50	.4		
Sunflower seed hulls	3.0	100	3.0	50	1.5	80	1.2		
Pasture Land	50.0	100	50.0	52	26.0	50	13.0	13.0	.9
Fallow Land	177.6	100	177.6	40	71.0	70	49.7	49.7	3.4
Range Land	1488.4	100	1488.4	46	684.7	100	684.7	684.7	46.1
TOTAL								1484.5	100.0

TABLE 7. Estimated current sheep requirements for feed in TDN compared with feed available, SAR.

Type of sheep and activity	Number of sheep	TDN per head per year	Total	Feed values available (TDN)	Surplus or deficit (TDN)
	1,000	Kg.	1,000 ton	1,000 ton	--
For fattening					
(at 45 kg live weight for 100 days)	3,500	109	381.5		
For raising					
Lactating ewes (at 54 kg -live weight)	4,239	338	1432.8		
Replacements and rams (at 54 kg -live weight	2,831	281	795.5		
Subtotal			2228.3		
Total			2609.8	1484.5	- 1125.3

TABLE 8. Annual precipitation in MM, stations in the Steppe, SAR 1970-1977[1/]

Station	YEAR							
	1977	1976	1975	1974	1973	1972	1971	1970
Palmyra	167.1	128.8	133.9	285.5	38.9	216.7	117.9	76.1
Al-Tanf	83.5	120.1	116.3	191.1	31.8	154.6	125.1	40.4
Al-Rakka	210.5	263.6	254.1	310.3	95.3	271.8	209.2	101.9
Deir Ezzor	85.5	197.9	197.9	300.2	49.8	240.1	174.1	124.0
Al-Abu-Kamal	139.2	158.5	192.0	322.6	63.3	188.2	159.2	73.3
Appraisal of rain-fall conditions:	Dry	Average	Average	Very good	Very dry	Good	Average	Very dry

1/ Central Bureau of Statistics, Statistical Abstract, 1978

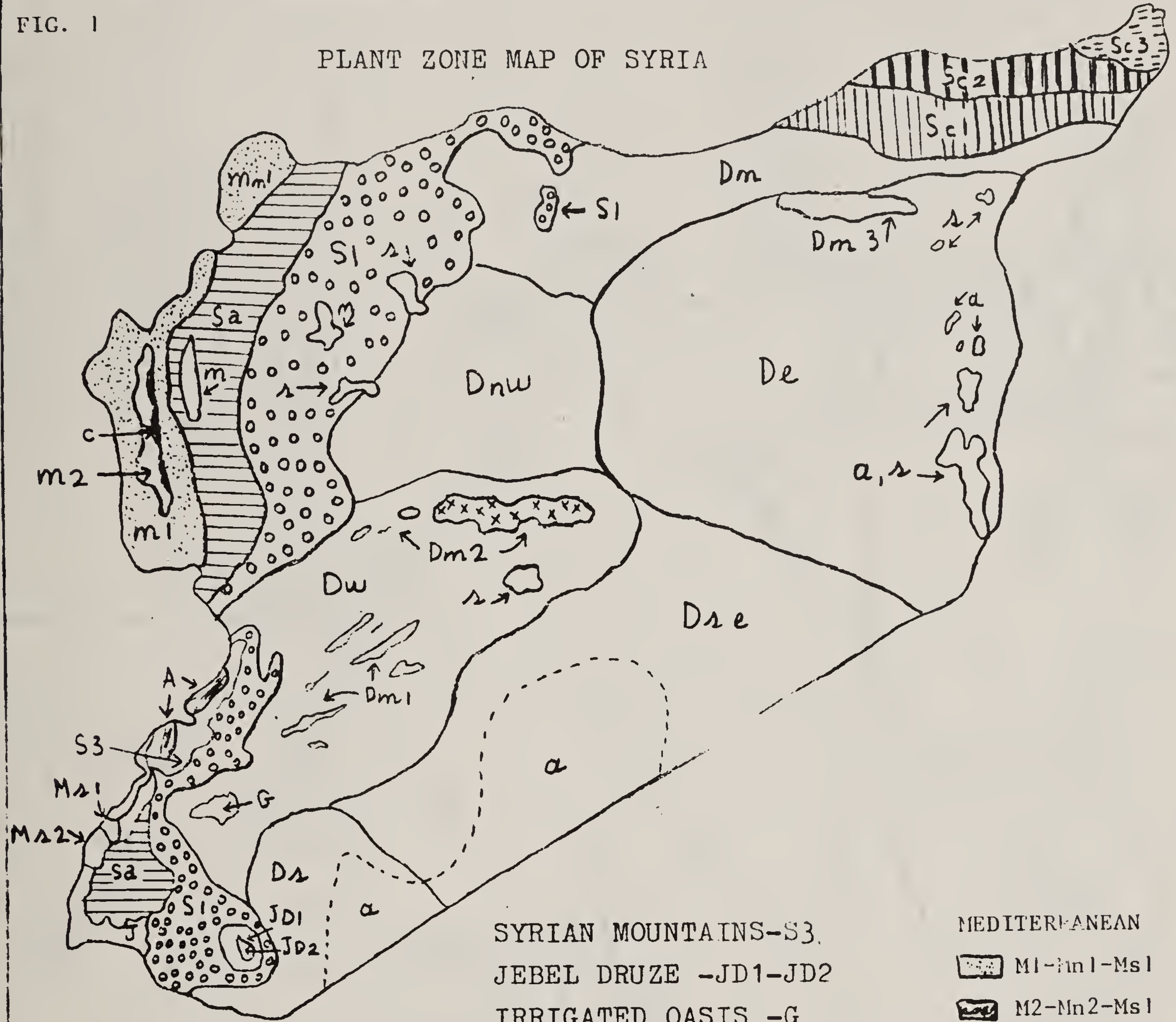
TABLE 9. Plant Geography of Syria[1]

Zone	Plants		
Steppic Zone	Artemisia herba-alba	Salsola spp.	
	Haloxylon articulatum	Senecio desfontainci	Peganum harmala
	Ephedra alata	Plantago notata	Noaea mucronata
	Achillea fragrantissima	Chamaemelon auricul- atum	Poa spp.
	Astragalus spp.	Silene coniflora	Salvia spp.
	Carex stenophylla	Erodium puverulentum	Anthemis spp.
	Centaurea laxa	Gymnarrhena mic- rantha	Evax contracta
	Adonis dentata	Arnebia decumbens	Malva aeqyptiaca
	Spergularia diandra	Malcolmia torulosa	Astragalus duppos- trigosus
	Schismus arabicus	Scbiosa aucheri	Stipa spp.
	Leontodon hispidulus	Koelpinia linearis	Filago spathula
	Micropus longifolius	Trigonolla radiata	Hypecoum pendulum
	Carrichtera annua	Helianthemum aegyp- tiacum	Atriplex spp.
	Tamarix spp.	Chenopodiacees halo- philes	Juncus maritimus

1/ Republique Arab Syrienne, Minisere De L'Agric. Department Des Sol Et De Chimie Agricole, Carte Phytogeographique Provisoire De Syrie (Legen De) Par Henri Pabot, Ecologiste de la FAO, 1957.

FIG. 1

PLANT ZONE MAP OF SYRIA



SYRIAN MOUNTAINS-S3

JEBEL DRUZE -JD1-JD2

IRRIGATED OASIS -G

SOUTHERN SYRIAN CONTINENTAL

SC1

NORTHERN SYRIAN CONTINENTAL

SC2

NORTHEAST SYRIAN CONTINENTAL

SC3

MOUNTAINS OF THE STEPPIC ZONE-Dm1, Dm2, Dm3.

STEPPIC ZONE-Dm-De-Dnw-Dw-Ds-Dsc-a-m-s

MEDITERRANEAN

M1-Mn1-Ms1

M2-Mn2-Ms1

CEDAR AND ALPINE

C-A

JORDAN RIVER(EAST)-J

EAST SYRIAN

S1

WEST SYRIAN

S2

SOURCE: ADAPTED FROM SYRIAN ARAB REPUBLIC, PROVISIONAL PLANT GEOGRAPHY MAP OF SYRIA BY HENRI PABOT, FAO ECOLOGIST, 1957 .

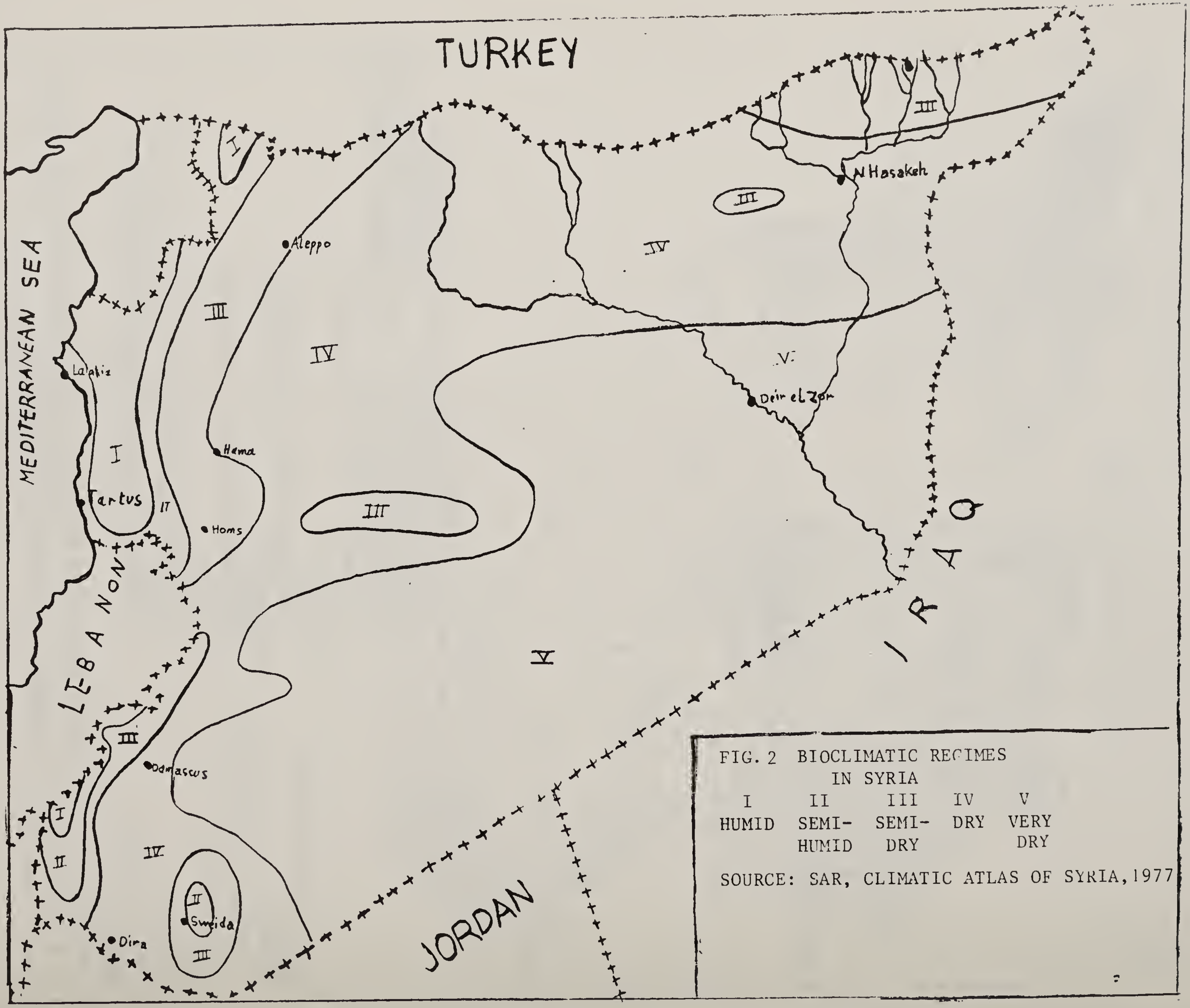


FIG. 2 BIOCLIMATIC REGIMES IN SYRIA

I	II	III	IV	V
HUMID	SEMI-HUMID	SEMI-DRY	DRY	VERY DRY

SOURCE: SAR, CLIMATIC ATLAS OF SYRIA, 1977

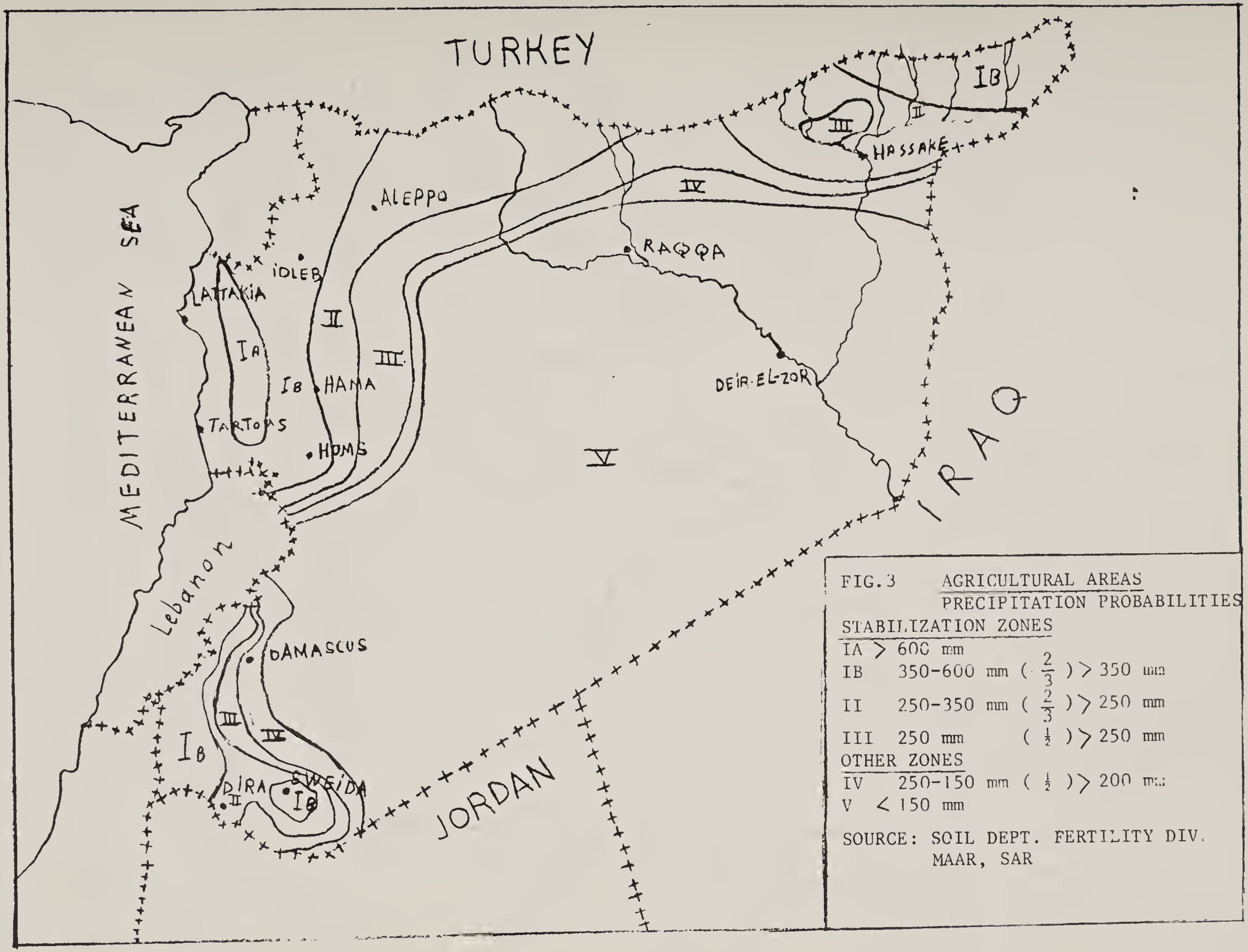


FIG.3 AGRICULTURAL AREAS
PRECIPITATION PROBABILITIES

STABILIZATION ZONES

IA > 600 mm

IB 350-600 mm ($\frac{2}{3}$) > 350 mm

II 250-350 mm ($\frac{2}{3}$) > 250 mm

III 250 mm ($\frac{1}{2}$) > 250 mm

OTHER ZONES

IV 250-150 mm ($\frac{1}{2}$) > 200 mm

V < 150 mm

SOURCE: SOIL DEPT. FERTILITY DIV.
MAAR, SAR

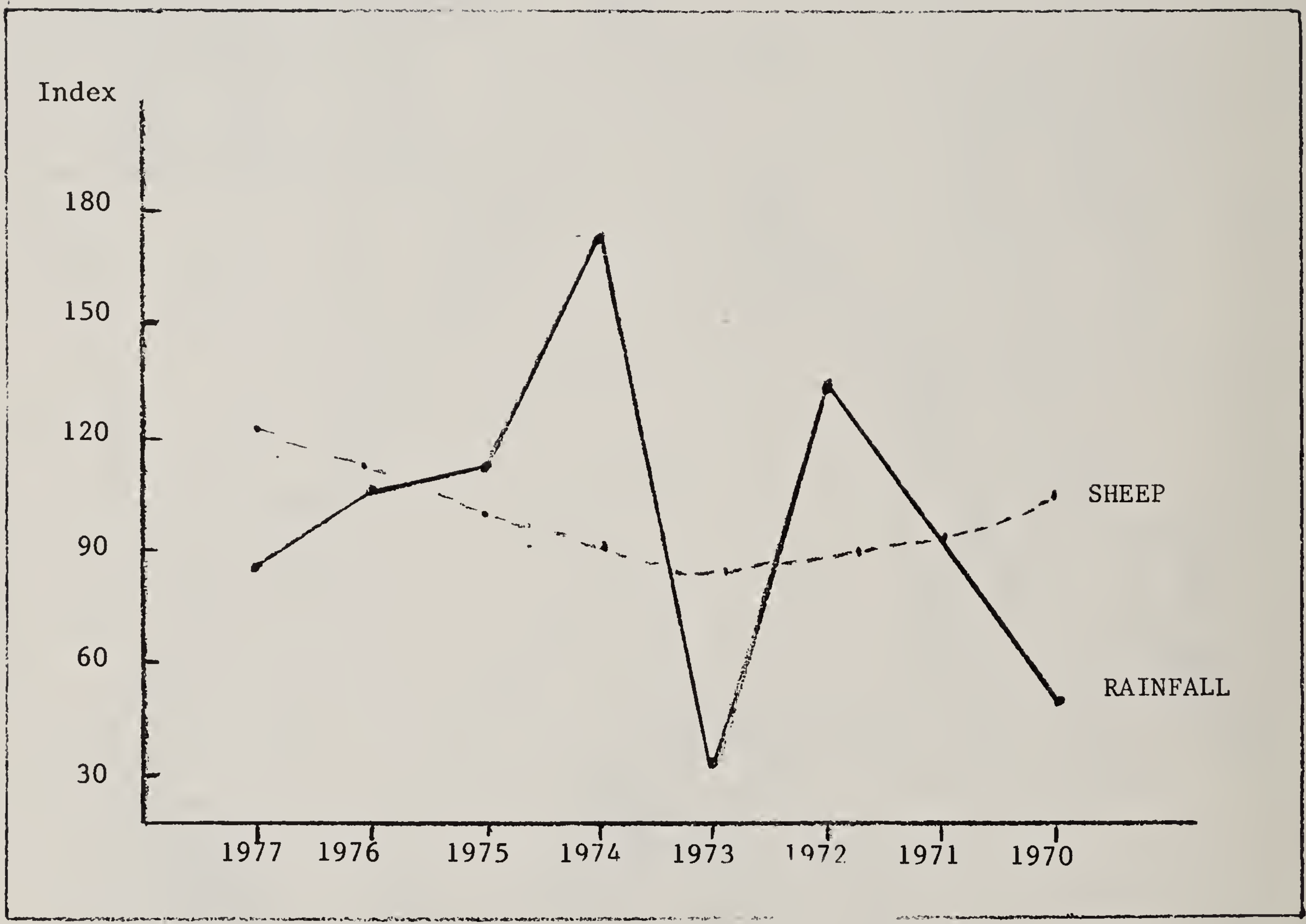


Fig. 4. Indexes of rainfall in the Steppe and sheep numbers in 1970-1977, data from Statistical Abstract, SAR.

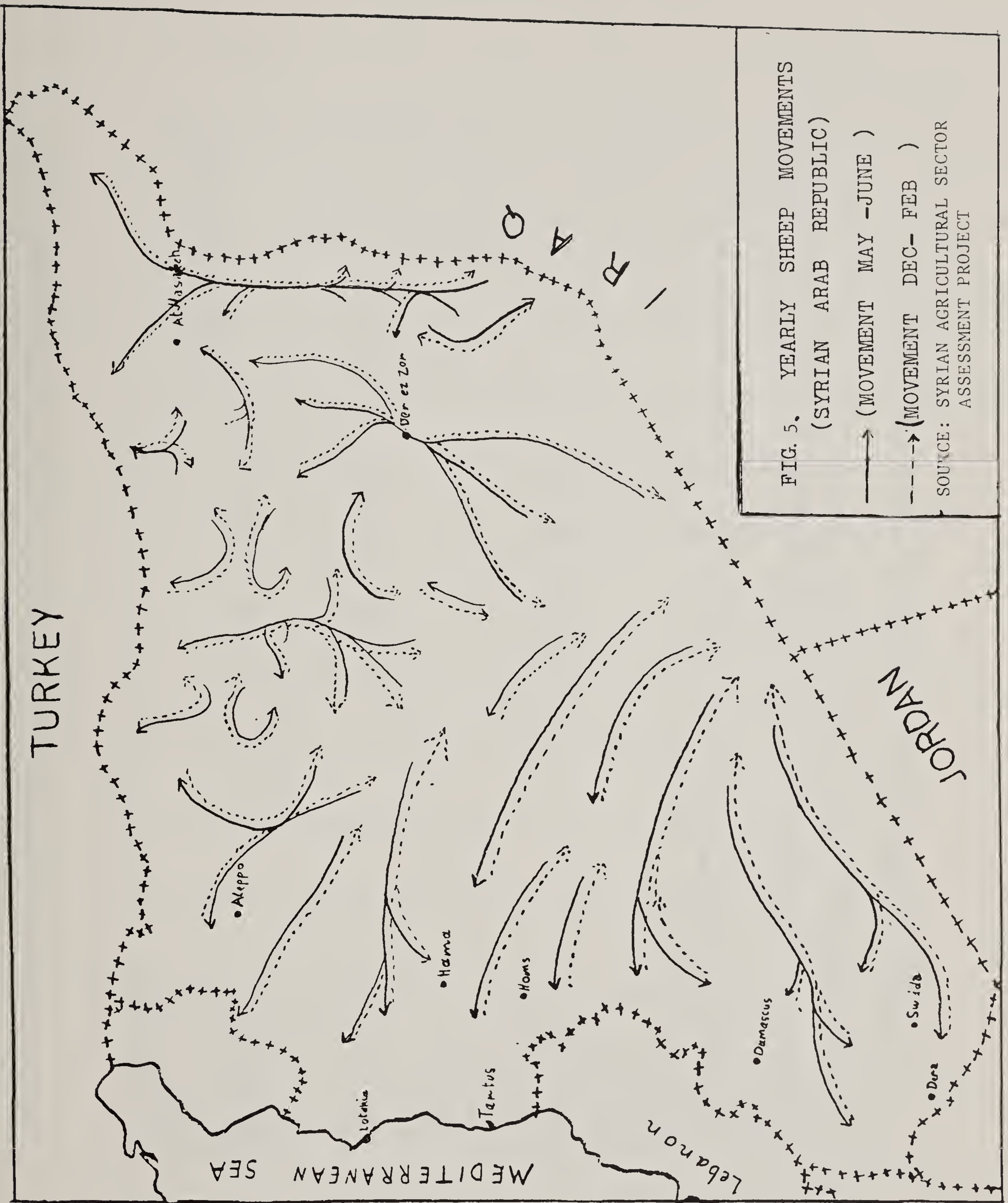
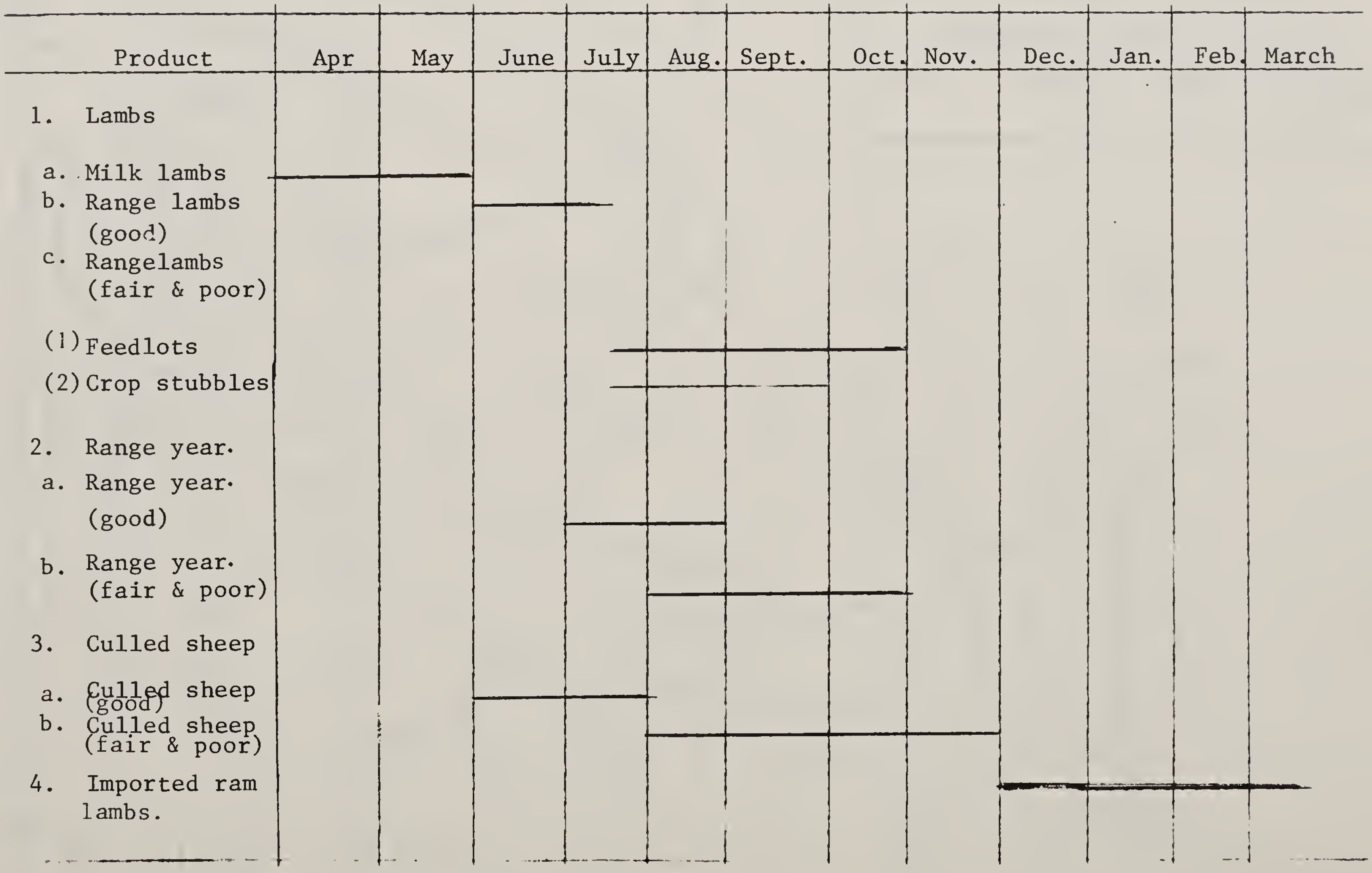


FIG. 5. YEARLY SHEEP MOVEMENTS (SYRIAN ARAB REPUBLIC)

SOURCE: SYRIAN AGRICULTURAL SECTOR ASSESSMENT PROJECT

Fig. 6 . Pattern of marketing sheep for slaughter by class of sheep and month



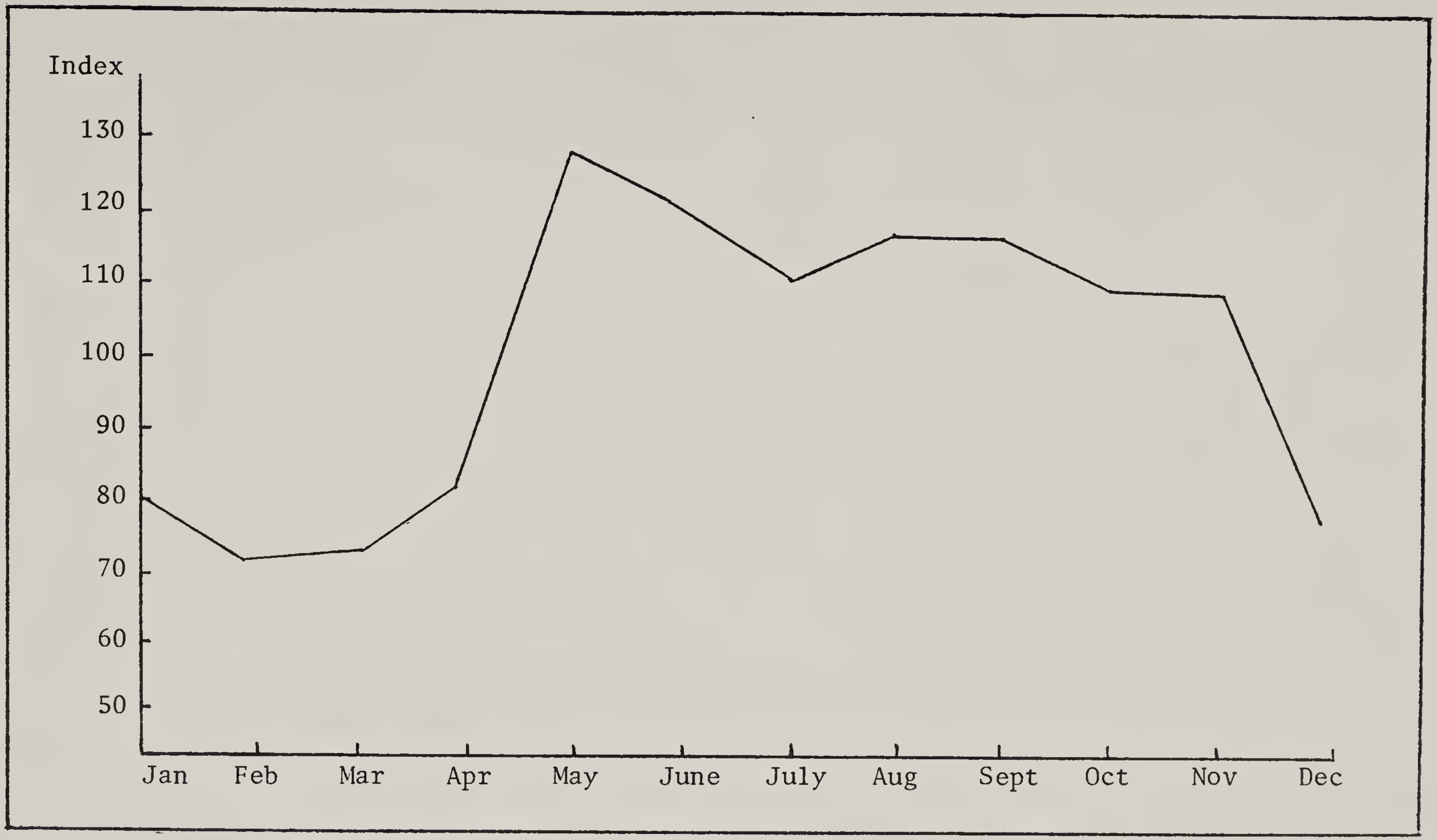


Fig. 7 - Slaughter of sheep in plants in Syria by months, 1976
(Total Slaughter = 1,163,318 head)

Source: Statistical Abstract, 1976, Ministry for Supply and Home Trade

Syria: Agricultural Sector Assessment

Volume 2: Natural Resources Annex

CHAPTER IV

FORESTRY RESOURCES

Based on the work of

Boyd W. Post

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PREFACE

This report is based on numerous interviews with foresters, forest nursery managers, Mohafaza agriculture leaders, and professors of forestry who have practiced forestry in Syria for some time. A trip into the more important forest areas of Syria provided an opportunity to observe the forests and some of the current forestry practices.

A counterpart forester from the MAAR, Mr. Suleiman Zeineddin, helped plan the trip by suggesting areas of importance. He was also very important in the communications process.

FORESTRY RESOURCES

A. Introduction

Probably nowhere else in the world is so rich in the artifacts of ancient civilizations as this region with its numerous archeological findings. From these, hypotheses concerning forests of the past may be formed.

At Ebla, about 60 km south of Aleppo, there are several holes in the ground around the main temple which are about 46 cm in diameter. These once contained timbers which were supports for a large roof. It is very likely that these timbers came from nearby, indicating the presence of excellent forests at the time of that city's flourishing, which was about 2500 B.C.

There is reason to believe that in the region between present day Al Rakka, Syria and Baghdad, Iraq there were extensive forests as recently as 800 years ago. Haroun El Rasheid, who ruled this area, had a summer palace near Al Rakka and a winter palace near Baghdad. According to histroical legend he was able to ride a camel from one palace to the other completely in the shade of trees! There are no trees to provide such shade today.

What accounts for the change in vegetative cover from forest to near-desert condition? In all likelihood the factor responsible for removal of the forests and for the events that followed leading to present day desertification is man. As man's number increased, more land was required to grow grain and graze animals. Naturally, the forests were removed to meet this need. This process still goes on in Syrian forest areas today.

Once the trees and protective vegetation were removed, the strong sun and wind interacted with man's plows and the desert expansion began. It will continue to expand until man takes the steps necessary to reverse the process or at least prevent further desert formation. Thus, the forest planting in Syria is really afforestation, not simply reforestation.

Forestry, as well as many other parts of modern agriculture, is an essential component of Syria's future, both economically and biologically.

B. Forestry Development

Modern forestry really began in Syria in 1952. Since that time the pace of activity has accelerated gradually. During 1952, the date of the earliest record available for government forestry activities, 73,260 tree seedlings were planted on a total of 33.9 hectares. During 1978, 22.5 million trees were planted on 12,000 hectares.

The Directorate for Forest and Afforestation was created as part of the Ministry of Agriculture in 1952. It has grown to 30 university graduates (10 forest engineers and 20 agricultural engineers) working in Syria. Technical assistance is provided by graduates of the Arab Forestry Institute (AFI) at Lattakia. There are about 140 graduates of AFI in Syria, many of whom are involved in nursery operations and afforestation. In addition, 265 forest guards, who are required to have 9 years of education, are responsible for enforcing the forest law.

Very important to the future of forests and forestry in Syria is a group of professors and researchers who hold Master of Science or Ph.D. degrees in forestry and related areas. These scientists must educate foresters and technicians who will not only perform their technical work, but also help the general citizenry to understand and appreciate present and future forests in Syria.

The World Food Program (WFP) of the Food and Agriculture Organization (FAO) has had a forestry project in Syria since 1968 in addition to the S.A.R. forestry effort. Project Syria 268 was titled "Construction of Forest Roads and Afforestation in Selected Areas". The beginning phase of this project lasted five and a half years, and the expansion phase lasted another five years, nine months. WFP assisted the S.A.R. in their program of afforestation and forest road construction by supplying food as part payment of wages to the labor force.

Restoration of a suitable vegetative cover on degraded, previously forested land and marginal agricultural land to achieve several goals is the primarily purpose of this afforestation. These goals are to control soil erosion, to increase water resources, and to improve the microenvironment, especially in regions where the desert is expanding. Second-order goals include expansion of timber production and provision of more recreational forested areas. Forest roads are essential to management of afforestation areas beginning with site preparation and tree planting, protection and tending of the stands, and timber harvesting. An added benefit is that these roads sometimes provide remote mountain villages connections with the existing roads. This WFP project has been quite effective and has accomplished the road building and tree planting envisioned in cooperation with the Directorate of Forest and Afforestation.

A new project, S.A.R. 2418, titled "Reforestation and Establishment of Green Belt", was started during the summer of 1979 and is scheduled to last three years. This project is to accelerate the afforestation carried out in the previous project and to begin a pilot phase of the green belt.

Self-sufficiency and import substitution are important potentials of forest management. According to the WFP Project Summary, the natural forests are already supplying 80 percent of the needs of two chipboard factories. However, we are aware of only the particleboard made by Lattakia Wood Co. from the waste plywood of imported African woods. Small poplar timber is used in construction, match manufacturing, and tool handles. Many poorly formed shrubby species are used to make charcoal. Syria is importing about 100,000 tons of timber, round and sawn, at a cost of about 100 million Syrian pounds ($25 million) annually.

By 1980, if the present schedule is met, the S.A.R. will have established 38,000 hectares of newly afforested areas since 1952. Directed largely toward controlling soil erosion and roadside beautification, this is a start toward satisfying Syria's demand for wood and wood products.

The total land area of Syria is 18,500,000 hectares (ha), of which an estimated 277,500 ha (1.5% of total) are normal density pine and hardwood forests. Another 155,400 ha (0.84% of total) are in open, shrubby stands. The 38,000 ha (0.20% of total) of afforested land would bring the total to 470,900 ha (2.54% of total) in 1980. Plans are to continue afforestation at the rate of 12,000 ha (0.065% of total) per year. If this rate is continued, by 1990 there should be 435,500 ha of normal density forest land, a 38% increase in 10 years.

It will require at least 20 years to complete the green belt and it will form a 20 kilometer-wide buffer zone between the desert and the humid parts of Syria, with a total length of 1,100 kilometers, and 22,000 km^2 or 2.2 million hectares (11.89% of total). This is a very significant proportion of the total land area which, when completed, should make significant changes in land use. These changes, by design, should be beneficial sociologically, biologically, and economically.

WFP will assist in establishing two green islands in Aleppo and Homs mohafazat as a pilot project. Strictly speaking this is not forestry in the normal sense, but rather horticulture. Plant materials to be used are almond and pistachio trees and grape vines, which are of drought-resistant varieties used locally and known to be adapted.

C. Natural Forests

Natural forests north and east of Lattakia in the vicinity of Kassab, Foruluq, and Slunfye were visited to obtain a first-hand evaluation.

On the major natural forest block near Ras El-Basit and the Turkish borders, referred to as the Kassab Forest, Pinus brutia is the dominant species. These stands are quite varied as to age, structure and stand condition. In some places there are many mature or overmature trees with adequate reproduction. However, it should be noted that many of this older generation have very poor form. This probably resulted from these trees having been left uncut during the period of unrestricted harvesting during World War I (1914-1918) and they now are the major portion of the standing volume. Slope of the ground in this area is very steep over much of the area and is observed to slide over the parent material when wet. This area has deteriorated from uncontrolled cutting, wildfire, intrusion by tobacco and fruit farms, and grazing.

Kassab Forest

This remaining natural forest of Pinus brutia is a highly prized resource which belongs to the people of Syria. Clearly, it therefore must serve the needs of these people. These needs include the continually produced resources of water from the forested watershed, recreation in the clean air of the mountains, and wood for fuel, lumber, paper, and other potential uses such as naval stores (resin to make turpentine).

Competition for the nonrenewable resource, the land on which the forest grows,is intense with farmers ever expanding their orchards, tobacco fields, and other crop lands into what was forested land. Apparently, attempts to establish boundaries have been unsuccessful, much to the detriment of the forest. It will continue to shrink unless, and until, a high-level decision is made to legally stop the reduction of forest area by encroachment. Many foresters believe that if an area were to be harvested it would very shortly be converted to orchard or cropland. Hence, there is great reticence to make any harvest cut until ownership of forest land is firmly established.

Assuming that this legal problem is soon settled and that the Directorate of Forest and Afforestation is realistically given charge of managing the land, a large number of policy decisions must be made. Primarily, it is essential to decide what objectives should be set for the forest. Perhaps the legislative branch has already provided guidance on this matter. If so that should provide the necessary direction. If there are no legislative intents, then some responsible authorities in the government should undertake consultations with the several agencies which could have a voice in setting the course or giving direction to the management.

Choices in objectives provide a spectrum of simple protection from fire and encroachment to a multiple resource management concept. Since the forests belong to all the people of Syria it would be logical to

consider the benefits to be available to the people. If the primary use were to be for water production, it appears that a relatively small localized area would benefit most. If recreation were to be the prime purpose, only those with the financial resources to travel to and perhaps stay in the forest would benefit -- along with the providers of lodging, food, etc. Should the decision be to emphasize timber production, a much larger number of the citizens would benefit because this would create many jobs in harvesting, transporting, product conversion (lumber, paper, etc.), and product sales. Progressing from single-purpose forestry to multiple-purpose forestry, it would be feasible to combine many of the objectives previously mentioned. For example, it is possible to properly harvest timber from the forest without destroying the water-producing capacity or the recreation opportunities.

Protection is not a simple matter. Over the last several years foresters have learned that fire is not always the enemy of the forest. Instead it is now scientifically well established that many coniferous forests need a certain type of fire periodically. The basic reason for this is that pine litter (needles, cones, etc.) accummulate on the ground and build a large amount of fuel which, when finally on fire, creates a forest-killing fire. The alternative then is to burn the litter under safe conditions (low wind, high humidity, etc -- low fire danger periods) at fairly frequent intervals. Many of the nutrients in the litter are quickly returned to the soil after a fire. Thus,controlled burning or prescribed burning may be an essential fire protection measure.

Other types of protection are concerned with damage from man, insects, and diseases. At this time man appears to be the most dangerous enemy of the Kassab. See excerpts from Forest Law in Appendix A.

The general condition of the Kassab forest is such that a large part of it is in need of timber stand improvement. Many of the trees should be removed because they are small, crooked, or too closely spaced. In some areas, it would appear feasible to completely harvest the existing stands and replace them with genetically superior seedlings which would grow faster and produce more desirable trees when mature.

Using proper harvesting methods, such as cable logging, it should be possible to begin a timber stand improvement (TSI) program by gradually removing these overmature and mature trees. This should permit the younger stock to develop at an increased growth rate. Without proper mensurational studies it is not wise to indicate a density of stocking for these areas. Therefore, it would be desirable when beginning a TSI program to design some statistical comparisons to determine optimum stocking for the conditions present.

Harvesting of timber around the world is changing as the need for wood fiber increases. In many places whole trees are being utilized, including the roots. Large machines have been designed to pull the trees from the ground. The trees are then chipped by machine and blown into a truck for transport to the paper mill or other point of use.

Such an approach could be used with the poplars to be harvested along the Euphrates River. Whether simply cut from the stump to permit regrowth or pulled out to allow species or variety change, the wood could be chipped before being transported to the mill.

Chipping could also work well for the TSI harvest of poorly formed pines in the natural forests north of Lattakia. This should increase total efficiency if the pine is to be used for chipboard at the Arab Corporation for Wooden Industries at Lattakia.

This forest, which has demonstrated the ability to be harvested and to regenerate itself, is commercially manageable for timber production.

Harvest Potential Per Hectare

A special report was requested by President Assad in 1978 because he wanted more forestry activity in Syria. The resulting report is a combined effort of the Directorate of Forests and Afforestations, forest engineers from all the mohafazat and Dr. Adnan Fares, Director of the Arab Forestry Institute, Lattakia. Some harvesting possibilities were presented in this report which apply to the 150,000 ha of commercial forest being discussed and are therefore quoted below.

AGE Years	DIAMETER cm	ANNUAL GROWTH mm	TREES/ha	ANNUAL WOOD PRODUCTION m^3
30	15	5	1250	97.5
40	20	5	1250	190
50	25	5	1250	321

Assuming a price of 800 S.P. per cubic meter of wood the value of the annual increment was calculated for each age group.

$$\frac{97.5\ m^3 \times 800\ \text{S.P.}}{30\ \text{years}} = 2600\ \text{S P /yr./ha}$$

$$40\ \text{years} = 3800\ \text{S P /yr./ha}$$

$$50\ \text{years} = 5136\ \text{S P /yr./ha}$$

It is obvious that these are forests which are capable of very valuable production and should immediately be put under a plan of management which will proceed to utilize this major resource.

Problems of a very serious nature and size must be overcome before management plans are implemented. First among these is to establish definite forest boundaries which cannot be changed by would-be farmers.

Forest laws appear to be quite strict, but enforcement is difficult. Perhaps a public show of concern by the President would help convince other officials of the desirability of solving this long-term problem.

Near Foruluq there are some good Pinus brutia stands. However, of more scientific interest, there are components of mesophytic ecosystems which are quite unusual in this region. These are small areas of deciduous species including Alnus orientalis (oriental alder) and Quercus sidocerris, which are dominant trees of about 25 meters height. In the understory are Quercus infectoria (oak) and two species of Sorbus (mountain ash). These large deciduous trees survive here only because of the soil moisture and favorable exposure.

Roads and increasing numbers of automobiles have made this area, which was until recently inaccessible, easily reached. The cool air and fine spring water have attracted many visitors who enjoy camping and picnicking under the shade of the big trees. In one sense it is good for people to enjoy the area. On the other hand, the soil around the tree roots is being severly compacted by automobiles and foot traffic. If this level of abuse continues, these trees will not survive. Already, it has been noted by Dr. Ibrahim Nahal (Professor, Faculty of Agriculture, Univ. of Aleppo , a forest ecologist) that rare specimens of herbaceous plants once present at this site are no longer present -- they were trampled out by humans.

If such areas are to be opened to the public, sufficient control by forest guards should be exercised to prevent deterioration. Parking should be allowed only on paved areas, trails provided and people educated to the scientific value of these species. The other alternatives are to allow continued deterioration or to completely restrict use of the area, making it a scientific preserve.

The scientific value of the Foruluq and Slunfye areas is considered to be quite great. These are small "island" remnants of the forest which existed here in previous times. It is only due to the relatively favorable environmental conditions at these locations that the species still present are able to survive. These rare specimens of ancient forests should be preserved for future study and the genetic resources they contain.

Slunfye forest near the top of Jebel el Ansariye contains many species not adapted to lower elevations. Quercus cerris, about 13 m in height and 20cm diameter breast height (DBH) , of rather poor form, are now predominant below the mixed conifer deciduous stands. Higher on the mountain are found the famous Cedar of Lebanon (Cedrus lebani),

fir (Abies cilicica), Ostraya carpinifolia, Fraxinus orientalis, Sorbus terminalis, Sorbus sarya, and Acer syriacum. Due to the high elevation, steep slopes, and thin soil, this is a fragile environment which is not adapted to commercial exploitation, a lot of human use, or grazing.

This remarkably valuable forest is being misused by grazing. Apparently the area will become more accessible to the tourists who frequent the Slunfye area in the summer by a new highway. In addition to these problems fire also is a grave danger. However, the worst offense to this once magnificent forest is agricultural encroachment. Forest areas have been converted to orchards and grain fields. It is doubtful that either are very productive under the rather harsh environment under consideration.

The government apparently encourages expansion into the forest by not setting the boundaries of the forest and by the grantings of loans and other encouragement to farmers to develop new land. These policies are clearly counterproductive and must be reconciled or there will be no forest remaining in a few years.

Shifting agriculture is the main problem of forestry. At this time, corrective action should be initiated.

D. Afforestation

On the mountain to the northwest of Damascus, the Jabel Kassioun, an ambitious tree planting program was started in 1975. During the four years 200,000 trees have been planted in this landscaping project. The Kassioun is a favorite place for viewing Damascus, especially after dark, as it is a very spectacular view.

Aside from improving the looks of the mountain there appears to be little benefit to this very expensive project. Watering will be required as long as trees are to be kept alive as there is no ground water on the mountain. Technically, the job is being handled well.

Throughout the field trip vigorous efforts were observed in the many nurseries producing seedlings for afforestation. Practically all of the seedlings are grown in plastic bags which eliminates the physiological shock of lifting and handling that bare-root seedlings go through. Thus, when the seedlings are planted, they have a good opportunity to grow.

The nurseries are quite labor intensive. For example, one nursery starts it seedlings densely sown in a soil-filled 5 gallon can and transfers them to the bags when about 2-3 cm tall. Other nurseries are sucessful in starting the seeds in the container in which they will leave the nursery - a much more efficient process. Some nurseries have good sprinkler systems whereas others depend on hand sprinkling. As might be expected, the nurseries near the seacoast have fewer problems and larger production

than do those in the hotter, drier parts of Syria. Palmyra's nursery has problems with salt in the soil and in the water. This is a very difficult problem to overcome.

Since these nurseries will be operating for a long time, mechanization of the nursery operations, especially in the larger ones, would reduce costs and improve efficiency.

Tree planting is done in the wet, cooler period of the year when the seedlings are dormant or nearly so. The work is done largely by volunteer groups such as farmers unions, school boys, and other public groups. Tree planting week was started by the Boy Scouts of Syria in 1945. Each December 29th the planting begins and lasts for a week to 10 days. This public support of tree planting is highly commendable because it indicates the public support for trees and forests. Hopefully such cooperation and interest will continue.

Earlier in this report it was noted that President Assad had requested a report on forestry which resulted in a new five-year forestry plan for 1978-1982. In an effort to keep the costs of labor and vehicles within reach, it was decided to use public organizations and school boys for labor and to use vehicles from other ministries on a need basis. Approval of this new plan was given by the Prime Minister October 1, 1978. Apparently, some further official action is required before the plan is fully authorized.

As labor becomes more expensive and difficult to obtain, it is very probable that tree planting machines should be considered in the areas where they would be feasible, such as relatively level land which is not too rocky. However, there will be an enormous amount of manual labor required to do the afforestation needed in Syria.

E. Poplar Plantations

Up to this point little has been mentioned about the planting of various Populus species in Syria. First it should be noted that there is a native species, Populus euphraticus, the Euphrates poplar. This species has been growing naturally in the Euphrates river valley where it serves some useful purposes, but it is of little value compared to the rapidly growing introduced species which have excellent form. One characteristic makes the Euphrates poplar important and that is its ability to grow in salty soil. The introduced trees will not do this.

It is quite likely that selection of the superior specimens for cutting over a very long period has left only the trees of poor form to reproduce. Therefore, it is possible that genetic selection and breeding may improve the form and growth rate of these species. At the same time the improvement program is started it would be desirable to also attempt some genetic crossing with the introduced varieties with

the goal of obtaining a fast-growing, well-formed, salt resistant tree for this valley which has much salty soil of limited use for other purposes.

At Al Thawra there are now 800 hectares of populus plantations. Part of these are experimental tests of species adaptability for climatic conditions and to test various spacings. As of now 100 ha are considered as a pilot project; 180 ha are at the model farm of Maskane; the remainder is at Al Thawra. Starting in 1978 they plan to plant 280 ha annually through 1988. Eventually, between 5% and 10% of the irrigated land in the project will be used for poplars.

The government is clearly very much interested in encouraging the growth of poplars in the Euphrates valley on both government farms and on private lands. The Agricultural Cooperative Bank will loan money to establish poplar plantings.

Combined planning for this project is done by the Ministries of Industry, the Planning Commission and the Euphrates Project. A major concern is provision of raw material to the paper mill at Deir-ez-Zor. This mill was built to use straw as a raw material, but now that animal production uses all of the straw, poplar is to be the raw material. At this time the mill must be modified to use wood instead of straw and it was not known when that would be done.

Poplar culture under irrigation is still in the development stage with much to be learned. For example, the initial plantings were from 2-year nursery grown stock. Last year they learned that the survivial was excellent when the cuttings were placed directly into the field thus eliminating the nursery step and the outplanting step.

There are problems which have to be dealt with in growing poplars in such a harsh environment. An aphid causes severe damage on P. nigra unless it is controlled by chemical spray for about 3 weeks. Populus ralba (Roumei) is not subject to this aphid, but does not have good form. Another damaging insect is a bark borer which also requires chemical control. During the first and second year weeds must be removed from the plantations to reduce competition. Although the soil has good structure, fertilization is being carried out according to the following schedule :

AGE	UNITS PER HA		
	N	P	K
2	50	50	50
4	70	70	70
6	100	100	100
8	130	130	130

Finally, or perhaps first of all, the trees must watered each week with 25-30 cubic meters (m^3) of water per hectare.

In other parts of Syria the two best Populus hybrids are 214 and 154. Unfortunately, they cannot stand the strong wind in the Euphrates valley and grow leaning over. Insects and disease problems also developed with these varieties, so they are not planted here.

This leads to the need for further variety trials to find other trees less subject to the adverse conditions in this environment.

Economics of irrigated poplar plantations is not well established. The decision to grow poplars for paper appears to have been made and they will be grown. Data from a report on this subject should be helpful.

Average income per hectare/year	11,350 SP
Average cost per hectare/year with land rent and interest	9,147 SP
Average net income per hectare/year with land rent and interest	2,203 SP
Profit	24 %
Average cost per hectare/year without land rent and interest	5,963 SP
Average net income per hectare/year without rent and interest	5,387 SP
Profit	90 %

It should be noted that four products were envisioned in the preceding example: matches, paper, plywood, and particleboard.

F. Wood Products

The Arab Corporation for Wooden Industries at Lattakia makes three products: plywood, particleboard, and panelboard. Their annual production is 9500 m^3 of plywood; 3500 m^3 of panelboard; and 3000 m^3 of particleboard (one half with veneer cover).

Plywood is the main product and is made from African woods imported from Ghana. The particleboard is made from the waste materials from plywood processing. Panelboard is made of strips of imported fir glued under pressure and covered with African veneer. The only local product used is about 90 m^3 of walnut (Juglan regia) from Ghouta near Damascus which is sliced into planchettes.

Their total production is sold in Syria. Still it is necessary to import plywood from Europe. A major problem is that the supply of wood from Africa is not adequate, and each year they have to shut down the production line for 3 or 4 months. Due to this shortage, there is interest in using poplar as a veneer over the particleboard. If this proves feasible there will be a new demand and market for large poplar logs. However, poplar is a very poor substitute for the high priced African hardwoods. In summary, the demand is greater than the supply of plywood. Locally grown wood could in time help meet these requirements, provided veneer quality hardwoods, such as black walnut or black cherry, are adaptable to irrigation culture, and they should be ·

The only other wood product observed was charcoal. A pile of charcoal was ready to be lit on the road up Jebel el Ansariye. A new road being built required clearing a fair amount of shrubby hardwoods and these were being used for charcoal. The process used is very primitive and time consuming. Some information regarding production and costs follows. Oaks produce 1 ton of charcoal for each 4 tons of wood, but fruit trees are less productive, yielding 1 to 5. Each mound requires 1 week to burn off. In the Lattakia area about 1000 tons of charcoal are produced each year, mainly from oak and alder.

Cost of Wood	400 SP
Labor	300 SP
Transporation (Variable)	150 SP
Market Price	1000 SP
Profit	150 SP

Even though the price and costs do not provide much of a profit several people are willing to bid on each sale of wood for charcoal production. The need for the product has been greatly reduced by the ready availability of bottled gas. In all likelihood the demand for charcoal will continue to decline.

Potential Wood Products

Natural forest of 150,000 hectares are certainly capable of producing pine lumber, poles, and pulpwood to satisfy the needs of Syria for wood and paper. The trees of poor form could be used in chip form for either paper or chipboard, both of which are needed.

With proper management oak lumber could be provided for the furniture industry which now imports high quality lumber.

Any of these options will require time to develop.

G. Urban Forestry

Both Aleppo and Damascus have planted numerous trees within the city for environmental improvement. These trees are pleasing to look at, provide shade from the hot sun, serve as windbreaks, and filter dust and noise pollution. The creation of parks and green areas within the cities of Syria is very desirable. Many of the large old cities have done well in this regard but much remains to be done.

H. Recommendations for Management of Natural Forests

These recommendations are based on discussions with the most knowledgeable and best informed foresters is Syria. Management recommendations for forests include :

Kassab Area

Highest priority must be given to establishing permanent legal boundaries and surveying of the forests. Otherwise, shifting agriculture will eliminate the forest. At the Arab Forestry Institute (Lattakia) there is technical expertise available in the person of Mr. Ahmed Abbar, who teaches photo interpretation and related topics having to do with estimating the present volume of timber. He also should be able to provide guidance in establishing and mapping the forest using aerial photography. The 1954 photos are no doubt out of date. New aerial photos should be made available for forest management purposes.

Protection from fire, grazing and encroachment are essential. Law enforcement must be intensified. Consider prescribed burning as a fire control technique.

A timber stand improvement program should be started which will remove older trees and allow the young forest to develop properly. Wood removed could be sold. Income derived should be identified and added to the regular appropriation for forest operations.

Along roads and streams, leave strips of trees for visual enjoyment and stream protection.

Foruluq Area

This area near the spring should be set aside as a scientific natural area of great significance. Present uncontrolled use is rapidly deteriorating the area and, if unchecked, will destroy it. It should not be harvested, but rather protected from the public. Relic plant islands of this sort are very rare as they are remnants of previous geological times. To destroy such vegetation by overuse would be a tragic mistake.

Slunfye Area

The lower slopes should be converted to coniferous species now being planted as the oaks occupying this area are of little value. Essentially, this is an area to be protected for watershed management purposes. Tree growth at these higher elevations is slow and not suitable for commercial production. Protection from the public here is highly desirable also.

Conversion Areas

Several areas have stands of low shrubby oaks which are of very low value. An example is an area northwest of Aleppo in which the Quercus coccifera was reduced to coppice. Conversion of these stands to adapted pines is very appropriate and should be carried through to completion. This will help to eliminate the goat problem in many areas and return them to economically useful production.

I. Recommendations for Forestry Research

A compilation of the forestry research which has been completed in Syria needs to be put together as background for a thorough problem analysis. Such a thorough review would eliminate duplication of effort. A surprising amount of research has been done from time to time. Such sporadic efforts provide some help, but forestry research must be a continuous, long-term process because trees are a long-term crop.

Forestry research now going on in Syria is being done only by ACSAD at Aleppo University, where Dr. Nazir Sankary is stationed. ACSAD's Director, Dr. El Khish, reports some results have been published on a "gaf" tree. These results should be considered by the Directorate of Forests and Afforestation.

Two possiblities appear feasible for forestry research at this time. One would be for the Directorate of Agricultural Research to add forestry to the research program. Decision on research priorities would best be made through consultation between the Director of Forests, and a committee of experts from ACSAD, Aleppo University, Lattakia University, all of which have some courses in forestry. This would provide expertise is watershed management, sand dune stabilization, mychorrigal relations (root fungi), forest ecology, and so on.

A second possible approach would be a contract arrangement with Aleppo University which already has research institutes for nearly everything except forestry. Two forest researchers there provide the strongest concentration of expertise near some of the problem areas. Graduate students could be trained under such a cooperative arrangement thus enlarging the resource of forestry experts trained in Syria. This could lead to the establishment of a four year forestry diploma program in time, if the demand is sufficient. An example of possible cooperation in research is the poplar work at the Euphrates Project where the forestry staff are not prepared for such research.[1/]

1/ See note on page IV-18.

A very important topic to include in a forestry research program is a forest tree genetics program. Two lines of research are suggested as follows:

Improvement of Native Species

The pines of northwestern Syria are in large part of poor form and growth rate. This is probably the result of selection of the best specimens for harvest around 1916-18. The dominant trees remaining to regenerate the forest were the crooked, short, slow-growing specimens. However, there are numerous good specimens now in some parts of the forest. Thus, there is sufficient high quality genetic material available to reverse the past negative selection process.

A scientific tree breeding program to provide seeds for the future forests is highly desirable for Syria. This work must be done by a well qualified forest geneticist. The large investments being made in afforestation could be more effective by using seeds from only the best of trees. The terms "mother trees" or "seed trees" are sometimes applied to this practice. However, the term "super tree" seems to capture the idea better in that this term implies faster growth, better form, and other very desirable characteristics.

Populus euphraticus should be considered for genetic improvement because of its potential for paper manufacture. In the salty soils of the Euphrates valley this naturally adapted tree could prove to be of considerable value. However, at present the specimens observed were of very poor form and slow growth rate. This may be the result of harvesting the best trees, that is, the tallest, straightest, etc., for roof supports, tool handles and other uses over a very long time, leaving only the crooked slow-growing trees to reproduce. There appear to be two possible main lines of approach to obtain salt-adapted poplars: through selection and improvement of the native species; and through cross-breeding with other poplars having good form and growth rate with the goal of obtaining in both cases salt-adapted, fast-growing trees with good form.

Nonnative (Exotic) Species Trials

There are several species which have not yet been tested for adaptability to Syrian conditions. Again genetic considerations should be stressed for highest potential of success. A few species suggested for trial include:

Pinus jeffreyi Grev. & Balf	-	Jeffrey Pine
Pinus lambertiana Doug.	-	Sugar Pine
Pinus monticola Doug.	-	Western White Pine
Juniperus virginiana L.	-	Eastern Red Cedar
Juglans nigra L.	-	Black Walnut
Prunus serotina Ehrh.	-	Black Cherry
Pinus ponderosa var. arizonica (Engelm.) Shaw	-	Arizona Pine
Fraxinus pennsylvanica var. lanceolata (Borkh.) Sarg.	-	Green Ash
Pseudotsuga menziesii Franco	-	Douglas Fir
Pinus eldarica	-	Afghanistan Pine

Undoubtably there are many other species adapted to the hot, dry Mediterranean climate.

J. Other Recommendations

Afforestation

In many parts of the world afforestation of badly eroded soils similar to those of Syria have greatly benefited by interplanting nitrogen fixing trees or herbaceous vegetation with the crop trees. Two trees well adapted here that should be planted along with other species are Robinia pseudoaccacia (Black Locust) and Cerratonia siliqua (Carob). It is recommended that this be tested and, if found beneficial, adopted as standard practice in afforestation.

As mentioned in connection with the trials of exotic species it is best to use species adapted to the planting location. For example, it is known that the Pinus halepensis needs 300 mm of water per year. It should be planted only where the rainfall is greater than 300 mm to allow recharge of the ground water reserve. If the water requirements of trees being considered for planting are not known it would be highly desirable to complete such research before starting major planting programs.

Nursery and planting operations use large amounts of hand labor. Mechanization should be used when possible to improve efficiency.

Extending Pulp Supply

Presently, paper is not recycled in Syria. This resource of used paper should be put to use rather than disposing of it by burning. Even in the United States paper is recycled to extend the supply of pulpwood.

This could be done by either or both the private sector and/or the government. Volunteer groups such as the Boy Scouts, unions, etc. could collect the used papers for processing and use the money earned to support their activities.

Volume versus Weight

Logs are now sold in Syria on a weight basis, which is not considered feasible in most of the world. The problem with this practice is that the trees will lose up to 20 percent of their weight after cutting simply by drying. Volume does not change and is a more rational way to deal in wood. It is suggested that consideration be given to use of one of the internationally accepted volume systems.

Communications

At present there appears to be little communication on professional subjects from outside Syria. There are many fine journals which would be of benefit to the forest engineers. Some effort along this line would appear highly desirable.

A second type of communication problem is the need for radios among the field foresters. Such modern equipment would be very helpful in fire control, law enforcement, and general operations.

Forestry Extension

There has been no extension program in Syria until very recently. It is strongly recommended that forestry be included in the new extension program to help explain the necessity to keep grazing, fires, and similar threats away from the new forests and the existing natural forests. Special educational programs could be developed for the needs of the various parts of Syria. The people must understand and be favorable toward conservation forestry or the effort made will be largely wasted by misuse.

Advanced Training. There is need for advanced training and education among the foresters in Syria. Several of them have mentioned the need, desire, and willingness to participate in either graduate programs or special training in the United States. Apparently one forester is now in the U.S. for such training with the USDA Forest Service.

Employment Opportunities

Forest and forestry related employment is a distinct potential in many parts of Syria. In afforestation people are required to prepare the sites, plant the trees, tend the trees, grow the seedlings in nurseries, and then protect the trees from fire, grazing, and man. Eventually, some of these trees will be harvested and this will require manpower.

Several years ago there was an experiment conducted to determine the potential of the Pinus brutia forests (Kassab-Foruluq area) for naval stores (resin) production. According to the authority who conducted the investigation, the resin was of high quality and the trees produced in good quantity. It appears that the idea of developing a small naval

stores industry was dropped due to the fear of fire ruining the forest. With such positive initial findings, it should be worth further investigation. If the demand for the product is high enough and the overall costs and benefits in proper relationship, this might prove to be a feasible new small industry for the Lattakia area.

1/ With reference to the recommendations on forestry research (page IV-14), the committee reviewing this report indicated that a Section on Forestry Research has now been established at the Directorate of Agricultural Research at Duma. This Section will assume responsibility for implementation of the rest of the recommendations on improvement of native species and on testing of non-native species for adaptability to Syrian conditions.

APPENDIX A

Taken from: "The Forest Law as Set by Legislative Decree No. 66, dated 21.9.1953."

Chapter VII
Penalties and Civil Duties

Item 102: Everyone that starts a woodfire while engaged in an illegal action is to serve a term of imprisonment that extends from six months to 3 years. As recommended by this decree.

Item 103: ...

Item 104: Everyone that cuts or roots up a tree in a manner contrary to the rules included in this decree or in violation of the conditions of his commitments will have to serve a 10 day - 3 months imprisonment sentence for each tree that he cuts and is to pay, besides, a fine that equals twice the value of the cut or uprooted tree. The term for imprisonment, however, should not exceed a maximum of one year.

Item 105: Everyone that breeds or grazes an animal in a woodland in contradiction of the rules included in this decree is to pay a fine of 3 - 6 pounds per head of sheep or cows, of 5 - 10 pounds per head of horses, mules, or pigs and of 10 - 25 pounds per head of goats or camels.

Item 106: Everyone that removes or takes away sand, stones, metals, earth, grass, green or dry leaves or organic fertilizers that originally belong to the woodlands or some of the woodland yields previously indicated in Item 2, is to pay a fine of twice the value of the removed object. A Decree of the Minister of Agriculture is to determine the base value for the fine every year.

Item 107: Everyone that violates the rules of this decree as included in the following items, the instructions or orders based on Item 4, passages 1 and 2 of Item 22, Items 27,28,40,51,61,84, and 91, passages 2 and 3 of Item 93 and Item 100, is to serve a term of imprisonment of up to 3 months. Same is to pay also a fine of 50-500 S P

The same penalty applies to all those who violate the rules recommended by Item 86 as well as by the first passage of Item 93 of this decree. The due fine should not be under a minimum of 100 pounds per donum or part of donum of the cultivated woodland.

Item 108: ...

Item 109: In case a more severe penalty than the penalty already indicated is set by another decree, the former penalty is to be applied.

Item 110: 1.Everyone that effects a material mischief in a woodland is to remove it or pay a fine for it. A payment in compensation of the loss and damage effected is also to be made when necessary. The objects removed illegaly from the woodlands will, in any case, have to be confiscated for the State Fund together with the implements used in removing them.

2. The commited party may also be forbidden to carry on with his investment practices in case he started on them before obtaining a legal license.

3. If a person who has been licensed to remove and transfer objects from the woodlands, removes more than 20% of the determined quantity, all removed objects are to be confiscated.

If the increase is exactly estimated at 20% or less, only the quantity that makes up the increase is to be confiscated. The penalty for such offenses does not, however, necessitate that the means used in the removal be confiscated.

Item 111:1. The Forestry Dept. has the right to demand of the woodland offenders compensation either through punitive institutions or in accordance with the rules of civil law without having to trespass the rights of the General Prosecution. The Dept. may be assisted in carrying out its penal procedures by officials that are to be appointed by the Forestry Director and that are to represent him before all courts and other judicial circles.

2. The Penal punishment will be lifted off if the offending party pays the minimum fine before the preliminary judgement is passed against him, and also if he, in this case, removes the effected damage or pays a compensation for it, which compensation is to be determined by the Forestry Dept. in the area.

Syria: Agricultural Sector Assessment

Volume 2: Natural Resource Annex

CHAPTER V

FISHERIES RESOURCES

Based on the work of

Lynn Hutchens

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PREFACE

This report is based on observations and interviews made during the period April 1-29, 1979 for the purpose of evaluating programs designed to develop the fishery resources of the Syrian Arab Republic.

Appreciation is expressed for the cooperation and information provided by the various officials contacted, and especially to my counterpart, Mr. Fouad Bshara, of the General Establishment for Fish.

FISHERIES RESOURCES

A. Introduction

Syria'a inland and marine fisheries produced about 29 percent of the estimated 11,500 metric tons of fish consumed in the country in 1978. Imports accounted for about 71 percent of this total. As shown in the following tabulation, which is based on data from the Appendix Tables of this report, inland waters produced about 2,324 metric tons, or about 69 percent of total domestic production on 1978. The marine fisheries produced about 1,055 metric tons, or 31 percent, in the same year.

Source of fish production	Estimated 1978 tonnage	Percent of total
Natural waters	1,864	16
Warm water farms	460	4
Total inland fisheries	2,324	20
Marine fisheries, total	1,055	9
Total domestic production	3,379	29
Imports, total (1977)	8,176	71
Total available	11,555	100

The overall trend in value of domestic fish production, in constant 1963 prices, was downward in the early 1970s, dropping from SL 1.9 million in 1971 to SL 0.5 million in 1975. However, in 1976 and 1977, the latest years listed in the Statistical Abstracts, the value in the constant prices was SL 3.7 million and SL 2.3 million, respectively. In current prices, total fish production was valued at SL 12.6 million and SL 11.6 million in these latest two years.

Programs for the development of Syria's fisheries have aimed at increasing the fish catch from both marine resources of the Mediterranean Sea, and from inland water resources, including rivers and manmade lakes behind dams, as well as on fish production farms. Implementation of fisheries development by the Ministry of Agriculture and Agrarian Reform is centered in the General Establishment for Fish, headquartered at Jableh in Lattakia Mohafazat.

Evaluation of the various fishery development programs is presented in the following sections of this report under the headings of Natural Water Fisheries, Trout Farms, Warm Water Farms, Marine Fisheries. The scope and nature of these components of Syria's fishery resources are presented in the Appendix Tables.

B. Natural Water Fisheries

Lake Al Assad, created by the dam on the Euphrates River at Al-Thawra, has an area 640 kilometers square (km2). Depth varies from 45 meters at the dam, to 35 m in area II, 15 m in area VII and less than 1 m above area VIII. The lake is 80 km in length and 17 km at the widest part. Primary purpose of the impoundment is irrigation water supply, followed by electric power production as the secondary purpose.

A German fishery team is developing a project concerned with limnology, assessment of productivity of the lake, fish population assessment, and small scale net cage culture of rainbow trout and carp.

The net cage site has a floating, anchored platform. The fish at the site were very active and appeared to be in excellent condition. This type of fish production appears to warrant larger scale development work. Capital investment costs are relatively modest, as compared with fish farm construction, although there will be continuing, moderate maintenance costs for nets, flotation material, platforms, and walkways. All food must be brought to the fish, as the quantity available from natural organisms is usually negligible under cage culture conditions.

The team's findings reflect the common experience with new reservoirs, i.e. an initial several years of relatively high fertility as the nutrients in organic source are utilized for rapid fish growth. Typically, this period is followed by declines to a lower fairly steady state of fish production. It appears that Lake Assad waters are on the low side of fertility levels due to insufficient phosphorus, and to formation of hydrogen sulfide in the bottom mud.

The main problem, at present, is that the fish population consists primarily of small cyprinidae which are undesirable as food fishes. The German team considers the best procedure is to establish a predator species, to convert the small fish to larger, usable, desirable fish.

Action attempting to bring this about had been initiated but delivery of the eyed ova of pike (Esox lucius) had been delayed and water temperatures were already climbing to the upper limit for successful hatching and rearing of pike fry.

Moreover, the number of pike stocked will be limited, and not large enough in size to immediately begin feeding on small fish in the lake. Experiments with pike in the U.S. have demonstrated that successful transplants of pike have been large fingerlings, of 150-175 millimeters , total length. If 100,000 pike of that size were released into the lake there would be a possibility of establishing the species. If pike do become established as a result of the present effort, it will be a rare occurrence for the first attempt.

Establishing a predatory species of fish to utilize the small cyprinids as prey is certainly the correct procedure. If pike do not thrive, then it would be well to experiment with native species, such as Siluris, and one of the Barbus species which people like as food. Some experiments to determine how to culture two or more of these native species might yield some information of value for future fish management work on Lake-Al-Assad.

It should be noted that planning of large impoundments should include fishery project needs from the very first stage. Every development project must be based on fully detailed, integrated planning, with each aspect of the problems thoroughly analyzed as an aid to decision making.

Only then can lasting benefits and maximum efficiency be realized. For example, a pre-impoundment survey of the fish population in the Euphrates River would probably have indicated that the future lake would be dominated by abundant, small size cyprinids. At that time plans could have been formulated for fish production facilities and work to select one or more large, desirable predator fish species could have been started. As it is, some additional years will be required to do the necessary work and realization of the potential fish production for food will be delayed.

Lake Qattineh, formerly known as Lake Homs, covers an area of 6,000 hectares to a depth of 6 to 7 meters, and has a volume of 200 million cubic meters. Production of fish is reported to be rather low and was estimated at about 650 metric tons (see Appendix Tables). The low production may be due to the mill dam, some 15 kilometers upstream, which serves as an obstacle to runs of fish leaving the lake to spawn at favored sites further up the river. Another factor may be the netting for fish during spawning runs in the masonry channels below the mill dam. In 1975, the Ministry of Agriculture and Agrarian Reform placed the lake under its jurisdiction and attempted to manage and control the fishing. The arrangement provided for licensing of fishermen, the catch to be divided 3/4 to fishermen and 1/4 to the Ministry. However, this attempt was unsuccessful and some 200 part-time fishermen from about 16 villages continue to fish free on this lake.

C. Trout Farms

The lack of water quality analyses and long-term air and water temperature recorded at fish hatcheries and farms was a handicap to assessment of full potential for fish growth.

In the case of the trout hatching and production facilities (Zabadani and Sinn Farm) it appears that water temparature are marginal or possibly excessively high during summer months precluding either survival, or good growth response by rainbow trout.

At Zabadani, the water temperature of 14.5°C in the spring supply is certainly too high for production of brood stock. A water temperature in excess of 11°C will result in poor quality eggs, and weak, deformed larvae, with a high mortality rate.

At Zabadani and Sinn Farm the water supplies are entirely dependent on pumps. The high investment and maintenance costs make economical production of trout for food a near impossibility. Trout must have a constant supply of water having an oxygen content of not less than 5 parts per million at the point of discharge from production units. Failure of electric power will result in very high losses.

The rate of change of water through the production units, rectangular and circular, was reported to be 1 change per 4 hours. For a satisfactory level of production the rate of change should be 2 or 2.5 changes per hour. By constructing trout production facilities to provide this higher rate of change, costs would have been substanially decreased, as a smaller volume of rearing space could produce the desired level of production. Suspended waste particles (solids) and dissolved waters (metabolites, such as ammonia and carbon dioxide) would be removed rapidly, ponds (raceways) would be more effectively cleaned by the faster current and oxygen levels would be higher.

For Zabadani, the calculated theoretical annual production, assuming 2.4 changes of water per hour through the production ponds is 43,000 kg. per year.

If trout production is not possible, some experiments with the catfish *Clarias gronovius* may be warranted. Cultural methods would have to be developed, as was done for the channel catfish *Ictalurus punctatus* in the United States. There may be other species native to Syria in addition to *Clarias* worthy of research for possible production.

At Sinn Farm (trout), with a water supply of one cubic meter per second (1m3 per second) the theoretical production calculates to 72,000 kg (72 kg per liter per second inflow). The limiting factors are believed to be insufficient rate of change and excessively high water temperature during part of the year. In addition, the requirement that the pumped water supply must be pumped back into the irrigation supply adds to costs and probably precludes economical production.

As a matter of fact, both Zabadani and Sinn Farm were extravagantly over built. Six rectangular raceways of $400m^3$ each could produce 30 metric tons of trout per year, at 2.5 water change per hour, with gravity flow and proper water temperature.

D. Warm Water Farms

Problems at fish farms for common carp (those fully scaled), mirror carp (partially scaled), grass carp, muller, and tilapia are somewhat different. Carp show good growth up to approximately 33°C; tilapia thrive up to about 35°C, water temperature.

The limitations observed were as follows:
Improper grade on supply lines. At Shatha, this was especially evident, the canal rises instead of being level slightly downgrade. As a result filling of ponds is impeded. This circumstance may exist at other points at Shatha and at other fish farms.

Not all ponds are used during the year due to excessive seepage through dikes; and to abundant growth of reeds in some ponds.

Outlet structures (monks) in ponds had insufficient screen area for rapid pond drainage. Small screen areas plug quickly with debris and small fish, and the pond can be drained only at slow rates. This was the case generally at all the warm water (carp , etc.) farms.

Carp had not spawned, although the water temperature was approximately 20°C, during the day. Carp will spawn at 12°C with induced spawning by use of hormones to give an early start on production. Fish farm managers know about and use this technique, but not until later in the season.

Ponds for production were shallow, as compared to U.S. ponds for production of carp and goldfish. At least one additional meter of water depth is provided in U.S. construction. Deeper water would permit an increased feeding rate, and yield a greater production.

Large inventories of pelleted feed stored in bags were noted. These were usually in storage for some months before distribution to the fish. This very likely means that nutrutive value has deteriorated substantially. The feed is probably serving mostly as an organic fertilizer rather than as direct food for fish. Conversion of feed flesh will be high in such a case. It may not be possible to schedule deliveries of fresh food, that is not more than 6-8 weeks in storage. In such a case green vegetation grown on the dikes and elsewhere on fish farms would be a possible, economical alternative. Fresh green grass, barley of other similar crops are satisfactory feed for carps, if sufficient amounts are available.

Records of water temperature - air temperature, water analyses and pond bottom soil analyses were generally not available, or if available, these were very recent and intermittent. Long-term records would be very useful to fish farm managers, as clues to production planning.

Determination of oxygen levels from individual ponds should be made frequently during the production season, for early knowledge about insufficient flow of fresh water to ponds, possible organic decomposition overloading, situtions leading to distress and loss of fish due to insufficient oxygen.

E. Marine Fisheries

Fishing in the marine waters off the coast of Syria has not been very productive due to small catches.

There are some natural limitations having a direct effect on sea fishing. Waters of the Miditerranean are known to be low in fertility. There are no upswellings to supply cold, nutrient-rich waters from the depths. The western entry to the sea is about 200 meters deep, assuring that near surface water from the Atlantic is the Mediterranean supply source. Syria's productive coastal waters occur in a narrow band to 200 meters dropping off steeply to abyssal depths, relatively unproductive of fish.

When viewing the full circumference of Mediterranean coastal waters, there are some notably rich fishing grounds, as a result of river deltas and a continuing influx of nutrient-rich water. Syria has very limited areas of that type. Trawling is not an effective method of fishing along portions of the Syrian coast due to occurrence of rocks or coral encrustations destructive to trawl gear. Such areas occur between Tartous and Baniyas, and northwest of Lattakia. Since the highly esteemed food fishes of the Serranidae group (sea basses) are known to favor rock areas, the use of baited traps would be justified for a period of test fishing. Such traps are used effectively off the Virginia coast. Baited long lines, with the hooks suspended several meters above the bottom, also warrant testing. To determine whether greater investments in sea fishing is warranted, a research program should be established to identify stocks of fish and abundance, to search for new fishing grounds, and to determine which tackle and methods are most effective.

Joining in research with other countries bordering the Mediterranean may be a worthwhile cooperative effort. Data and experience can be shared and costs might be lowered. Such a joint, cooperative program is now shaping up. The Government of Syria may wish to join with its neighbors in this FAO sponsored effort to investigate this method of producing fish and shellfish, for it is generally known that the close inshore waters under 200 meters in depth are overexploited.

F. Recommendations

Physical Limitations

1. Correct the physical limitations at fish farms, as follows:

   - Reconstruct supply canals where it is determined by a capable engineer that grades are improper for best distribution of the water supply.
   - Construct outlet structures with adequate screen area. (See illustration Fig 5 in FAO Report No.1045 A).
   - Remove vegetation, with particular emphasis on the reeds resembling bamboo, noted at Shatha and Kalaat el Moudik. Drying the ponds and destruction of vegetation by cutting them on the dikes and cultivating the pond bottoms is preferable to herbicide use.
   - Complete the planned construction of fish facilites at the existing farms.

Fish Cultural Practices

2. Impress on fish farm and hatchery personnel the need to capture, handle and transport fish in the most gentle fashion possible. Do not cause them to be out of water for more than few seconds of time. Weighing a tub of fish in a layer 30 to 40 centimeters deep with no water in the tub will kill a lot of fish.

3. Prepare nursery ponds in advance of stocking, sufficient to permit a build-up of natural organisms, especially zooplankton and phytoplankton.

4. Continue to experiment with methods to secure earlier spawning in the interest of a longer growing season, i.e., hormones, the use of which is known by some personnel at fish farms, and with alternating the raising and lowering water level in holding ponds.

5. Continue regular feeding until water temperature in ponds drops below 10°C. When temperatures in ponds are less than 10°C, continue to offer feed at intervals of several days. If fish surface and swim about actively at such times they can be observed and presumed to be taking feed. Continue distribution of feed until the fish stop feeding.

   Arbitrarily stopping of feeding usually results in loss of weight and increased mortality. However, if a well-managed pond has abundant natural feed, which should be determined by test netting with fine mesh plankton nets and bottom sampling equipment, the need to provide supplemental food may be of little importance.

6. Feed fresh pelleted food. Experiment with feeding green forage produced on pond dikes and other areas of fish farm land, in lieu of using pelleted feed held in storage for months.

7. Keep accurate records at fish farms. (The two fish culture manuals placed in the technical files of the assessment project provide forms which can be adapted for fish farm use here.)

   When these items enumerated above have been attended to, it is estimated the production of fish on farms could be increased to 3500 metric tons from the present level of somewhat less than 500 tons.

Additional efforts

8. After the preceding items of work have been accomplished, consider construction of an additional two or more fish farms, avoiding the pitfalls which limit production at existing farms. Priority should be assigned to warm water, i.e., pond fish culture. Potentials are very limited for significant trout production since water tempertures in Syria are marginal for cold water (trout) production. (A basic publication placed in the technical files of the assessment project provides information on locating facilities for pond fish culture.)

9. Increase the harvest of fish from natural waters by incentives to cooperatives, or use of government-operated gear. Experiment with large haul seines and trap nets such as fyke (hoop nets). These nets are non-selective in comparison to highly selective gill nets. Selective nets take certain species and a narrow range of fish size, depending on mesh size.

10. Experiment on a larger scale with net cage culture of fish in natural water, as is now being done on a small research type operation in Lake Al-Assad.

11. Establish a small group of fish research and fish management personnel for solving marine and inland fish production problems. Joining with other countries in a cooperative effort on the Mediterranean may be the least costly approach to increase the yield of fish from the sea for Syria.

    This small group should have one person trained in statistical methods to work on fish stock assessment. A fishery management biologist capable of providing information for resolving fish hatchery and fish farm problems is a high priority need. Such a person would be able to give continuing attention to the many questions about brood stock, spawning methods, feeds and feeding, disease indentification, pond stock rates, vegetation control, water management, that is, rates of inflow and rates of change, and others of a similar nature. Perhaps such a person would be abailable through AID or FAO for work on near term needs.

12. To overcome bottlenecks arising from lack of trained fishery personnel, selected staff should be sent to fishery training programs, such as at Auburn Polytechnic, Auburn, Alabama, or at the National Fishery Center operated by the U.S. Fish and Wildlife Service at Leetown, West Virginia.

General

13. Carefully study the manpower and equipment situation in the inland fishery program. It appeared to me that there was not enough equipment, and possibly too much manpower considering the overall organization. Fish hatcheries and farms everywhere always need the best fish transportation equipment for on-hatchery and off-hatchery use, and tractors and machines for cultivation and control of vegetation.

14. Build no more trout production farms that depend upon a pumped supply of water. Costs are too high and fish losses are almost sure to be catastrophic. Gravity flow is much the better method of gaining a water supply at trout hatcheries and farms.

15. Develop a method of collecting fishery data for inclusion in the Statistical Abstract regarding fish farm production, amounts captured from natural waters and production by cooperatives. A major licensing of fishermen and enforcement program is costly and unpopular. A knowledge of the productivity of water coupled with a knowledge of fishing effort would provide a basis for annual estimates. This could be one of the tasks for a research/management team recommended in 11 above.

Appendix Table 1: Components of Fishery Development Programs, S.A.R., 1979.

NAME	PURPOSE	REARING FACILITIES	SIZE	WATER SUPPLY	PRODUCTION 1/ Planned 2/ Actual
Trout Farm					
Zabadaneh	Rainbow trout hatching, and production for consumption.	22 hatching troughs	3m x 0.2m	600 liters/second pumped - only. (9510 gallons/minute) PH.7. Temperature	30 tons for consumption 1/
					6,000,000 eggs 1/
		50 indoor rearing tanks	3m x 0.8m	14.5°C (actual 4/4/79)	1,350,000 6month 1/ fingerlings.
	500,000 one-inch fingerlings, on hand, April 4, 1979.	98 circular ponds	15 m^3, each	21°C - max (estimated)	
		22 rectangle ponds	48 m^3, each	no annual record of temperature	
	2 million eyed eggs from Italy expected in a few days.	6 brood ponds rectangle	200 m^3, each		
			$2056m^3$ rearing space not including brood ponds, ($1200m^3$, total) rearing tanks, troughs.		
Sinn Farm	trout for consumption from fingerlings to be supplied by Zabadani	56 double raceways	32m Length	$1m^3$/second	None, new farm, not completed.
		1 water change per 4 hours	8m Width	16 C ? *	
			0.8m Depth	spring supply, all pumped electric pumps, or at certain times, by water turbine	
		$2048m^3$ total rearing space			

* No annual record

Continued

Appendix Table 1: (continued)

NAME	PURPOSE	REARING FACILITIES	SIZE	WATER SUPPLY	PRODUCTION 1/ Planned 2/ Actual
Warm water farm					
El Ghab Unit	Common carp	8 production ponds	41.0 H (hectares) (Total)	$1m^3$/second	148.39 tons 2/ 1978
A) Ain Taqa Farm (15 yrs old). polyculture	Grass carp Mirror carp Tilapia	4 ponds spawning and holding ponds	2.0 H		238.5 tons 1/ 440,000 6 month carp 920,000 1 yr carp
		36 ponds, hatching.	$25m^2$ (each)		
B) Shatha Farm (4 yrs old) polyculture	Common carp Grass carp Tilapia - for consumption and finger-lings for sale.	27 ponds production	2 H each	$1m^3$/second* Temperature variable 4/3/79 - 18°C 4/4/79 - 21° 4/15/77- 19.5° In winter of '78-79 strong wind from mountain (7°C) - killed tilapia	146 tons 2/ (1978) including 666,000 fingerling carp 252 tons, 1/ (1979) including 800,000 carp fingerlings
		11pond - for fingerlings	0,5 H		
		12 ponds (holding ponds)	$200m^3$		* A problem - $1m^3$/second available at inlet, but supply canal lies up-grade, so canal only about ½ to 2/3 full - at a point several hundred feet downstream, as a result of error in setting grade stakes prior to construction of concrete canal.
		27 ponds for spawning (2 are to be concreted)	$120m^2$	PH 7.0	
		1 pond	$8500m^2$	All water pumped from irrigation canal	
		2 ponds	$400m^2$		

Continued

Appendix Table 1: (continued)

NAME	PURPOSE	REARING FACILITIES	SIZE	WATER SUPPLY	PRODUCTION 1/ Planned 2/ Actual
C) Roog Farm polyculture	Grass carp tilapia	12 ponds, for consumption	5.4 H Total 150-175 cm deep	$1m^3$ Temperature 16°C but variable depending on air temperature	53 tons (carp) for consumption
		12 ponds for fingerlings up to 6-8 months	$3500m^2$ (each)		42.5 tons (carp) fingerlings all tilapia died, due to cold weather, 4°C in January
		18 hatching* ponds	$200\text{-}300m^2$ (each)		
		4 concrete ponds to hold fish for sale. (only 10 ponds for consumption and for fingerlings were operated in 1978)	$200m^2$ (each)		* difficult to drain, screen area too small, and ponds did not drain completely.
D) Kalaath el Moudik		new, not completed			None

(continued)

Appendix Table 1: (continued)

NAME	PURPOSE	REARING FACILITIES	SIZE	WATER SUPPLY	PRODUCTION 1/ planned	2/ Actual
Sinn Farm	fish for consumption		80 H	1 m^3/second	150 tons 1/	112.642 tons 2/
- polyculture	and fingerlings for sale. common carp mirror carp grass carp tilapia mullet.*		Total	16^{o}C -spring supply	1,201,000 fry.1/	1,302,000 fry 2/

* probably Liza saliens

(continued)

Appendix Table 1: (continued) 1/ Planned 2/ Actual

NAME	TYPE OF FISHERY	1978 PRODUCTION	KINDS OF FISH	TACKLE
Natural Water				
Branch of Thawra Lake Assad	Fishermen Cooperative	Total 1213,5 2/	Cyprinidae	gill net, haul seine, 1 small trawl
	Individuals	1250 1/ 0 tons	Mullet (Liza abu)	
	Research Program	42 1/ 0 tons	Siluris sp.	
		22 1/ tons		
		(1692)		
Homs Unit		650 tons (est.)	Carp, tilapia	gill nets
Lake Qattineh	Individuals			
Damascus Branch		10.9 tons		

Mziereep - a new fish farm - 6 H. Not in production.
2 ton, estimated production.

Room Dam - production in some years - occasionally dry
8 ton

Rastan Dam - 2000 H. - licensed to private operator - production unknown, 1978.

(continued)

Appendix Table 1: (concluded)

NAME	PURPOSE	PRODUCTION	EQUIPMENT AND VESSELS
Sea Fishing			
Branch of Marine Fish (Lattakia	Experimental effort - to identify new trawling areas and size of fish stocks	2/ 100,4 tons 1/ 180 tons	Difficulty not enough experienced personnel to operate boats and tackle. Need agreement with Turkey, and Egypt, to to beyond coastal waters of Syria. 3 belong to Branch of Marine Fisheries, i.e. General Establishment of Fisheries at Jabili, capable of trawling and purseseining, classification AC - high water, coastal Dimensions: 22m (1) 6m (w) Displacement: 100 tons H.P. 370 Refrigerator capacity: 30 m^3 Fuel Oil: 30 tons, about 12 days supply Steel Hulls, built in France, Dunquerque 1976
Private Coastal fishermen, 3 trawlers and 350 feluccas Lattakia	Subsistance and for market	1978 (ACTUAL) 673863 kg. 23115 66025 78225 113300 954,528 kg. or 954.5 m tons	2 belong to cooperative for Fishing. Old wood hulls. H.P. 180-200 Trawl only. 1 belongs to Port Company workers. Wood hull, 12 years old H.P. 150-170 Trawl only